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A SYSTEM

A SYSTEM OF ANATOMY WITH THE PHYSIOLOGY.

PART VI.

CONTAINING A DESCRIPTION OF THE

DIFFERENT VISCERA.

CHAP. I.

Of the HEAD.

BESIDES the brain, which is contained within the cranium, the head presents to us the organs of sight, of sound, of smell, of taste, and the greater part of those which serve for deglutition.

THE PERICRANIUM.

Besides the external integuments of the head, viz. the hair, skin, and cellular substance, there are two other expan-

ſions on the head; the firſt is the tendon of the occipito-frontalis muſcle, the ſecond is the pericranium, which covers the external ſurface of all the bones of the cranium.

The external part of this membrane may be ſaid to ſeparate from the other at the ſemicircular plane upon the ſide of the cranium, mentioned in the deſcription of the bones, and becomes a very ſtrong aponeuroſis, which covers the temporal muſcle, and is afterwards fixed to the external proceſs of the os frontis, and to the upper edge of all the zygoma. The reſt of the pericranium is connected to the other parts of the head.

The head is generally conſidered as one of the three principal cavities of the human body. On its outſide are ſituated the ſeats and baſes of ſeveral very complex particular organs; whereas on the inſide it contains only one, namely the brain, which is indeed the primum mobile of the whole animal oeconomy. The mechaniſm of this organ is very little known; and the ſtructure of its different parts, even of thoſe with which we are ſuppoſed to be moſt acquainted, is very difficult to be demonſtrated.

Sect. I. *Of the* Brain *and its* Appendages.

The name of *brain* is given to all that maſs which fills the cavity of the cranium, and which is immediately ſurrounded by two membranes, called *meninges* by the Greeks, and *matres* by other antients, becauſe they were commonly of opinion, that theſe membranes were the origin, and, as it were, the mother of all the other membranes of the body.

This general maſs is divided into three particular portions; the cerebrum or *brain* properly ſo called, the cerebellum, and medulla oblongata. To theſe three parts contained within the cranium, a fourth is added, which fills the great canal of the

the ſpina dorſi, and is known by the name of *medulla ſpinalis*, being a continuation of the medulla oblongata.

The meninges, or membranes, are two in number; one of which is very ſtrong, and lies contiguous to the cranium; the other is very thin, and immediately touches the brain. The firſt is named *dura mater*, the ſecond *pia mater*. This laſt is again divided into two; the external lamina being termed *arachnoides*, the internal retaining the common name of *pia mater*. We begin with theſe meninges.

§ 1. *Dura Mater.*

Situation in general. The dura mater incloſes the brain and all its appendages. It lines the inſide of the cranium, and ſupplies the place of an internal perioſteum, being ſpread in holes and depreſſions, and covering all the eminences in ſuch a manner, as to prevent their being hurtful to the brain.

Diviſion. In deſcribing the dura mater, we muſt take notice, 1. Of its compoſition. 2. Its adheſions to the cranium. 3. Its folds or ſepta. 4. Its productions, veſſels, and nerves.

Compoſition. The dura mater is compoſed of one lamina; although it may, by maceration, be divided into two or more. Its texture is very cloſe and ſtrong, appearing to be partly ligamentous and partly tendinous.

Adheſion. The dura mater ſticks cloſely to the cranium by a great number of filaments of the external ſurface, which enter the pores of the bones, almoſt every where, but more particularly at the ſutures both above and below; and by penetrating theſe joints, they communicate with the external perioſteum. Theſe filaments are, for the moſt part, ſmall veſſels, which being broken in ſeparating the dura mater

ter from the ſkull, cauſe a great number of red points to appear on the external ſurface of that membrane.

It adheres much more to the whole inner ſurface of the cranium in children, and young perſons, than in thoſe of an advanced age, when the filaments become very ſmall, being compreſſed by the contraction of the bony pores; and conſequently they are more eaſily ruptured, by any force applied to them.

Theſe adheſions are formed entirely by the outer ſurface of this membrane, the inner part of it being very ſmooth and poliſhed, and continually moiſtened, much in the ſame manner as the peritonaeum and pleura are, by a fine fluid diſcharged through its pores.

Folds and ſepta. The dura mater ſends off ſeveral proceſſes; three of which form particular ſepta, that divide the brain into certain parts. One of them is ſuperior, repreſenting a kind of mediaſtinum between the two great lobes of the brain: The ſecond is in a middle ſituation like a diaphragm, between the cerebrum and cerebellum: The third is inferior, between the lobes of the cerebellum. The ſuperior ſeptum is longitudinal, in form of a ſcythe, whence it is termed the *falx of the dura mater;* and it may likewiſe be called *ſeptum ſagittale, verticale,* or *mediaſtinum cerebri.* The middle ſeptum is tranſverſe, and might be called *the floor of the cerebrum, the diaphragm of the brain, tentorium cerebelli.* The inferior ſeptum is very ſmall, and runs down between the lobes of the cerebellum; on which account it may be termed either ſimply *ſeptum cerebelli,* or *ſeptum occipitale minus,* the middle partition being looked upon as the ſeptum occipitale majus.

The ſuperior or vertical ſeptum, called the *falx of the dura mater,* is a long and broad fold or duplicature of the internal part, reaching from the edge to the criſta galli, along the ſagittal ſuture, to the middle of the tranſverſe ſeptum; which

which it joins in ſuch a manner, as that the lateral laminae of the falx are continuous on each ſide with the neighbouring portions of the ſuperior lamina of the middle ſeptum.

It is broader where it joins the middle ſeptum than at the os ethmoides; and it is thicker at that edge which adheres to the cranium than at the other, which lies looſe, and is very ſharp; and from this reſemblance to a ſcythe, it had the name of *falx*.

The tranſverſe or middle ſeptum, called *tentorium cerebelli*, is fixed to the os occipitis, along the grooves of the lateral ſinuſes, and thoſe of the great angles of the apophyſes petroſae, all the way to the poſterior clinoid apophyſes of the os ſphenoidale. By this ſituation it forms a ſort of floor, tent, or ſhallow vault, on the fore-part of which is a large notch almoſt of an oval figure.

This ſeptum divides the cranium into two cavities, one large, or ſuperior, and the other ſmall, or inferior, which communicate together by the great oval notch. It is formed by a particular fold, and a very broad membrane of the internal part of the dura mater; and, in the natural ſtate, it is very tenſe, becauſe of its union, or rather continuity with the falx.

This union or continuity of theſe two ſepta keeps them both very tenſe, ſo that the middle ſeptum is capable of ſuſtaining a conſiderable weight without ſinking downward; and the falx is able to reſiſt lateral preſſures, without giving way to the right or left ſide.

We may be convinced of this reciprocal tenſion, by firſt touching theſe two ſepta in their natural ſtate; and again, after they have been cut one after the other, according to their breadth; or rather after having cut in this manner the falx in one ſubject, and the tranſverſe ſeptum in another: For, as ſoon as the falx is cut, the other will be perceived immediately

immediately to loſe its tenſion and firmneſs; and the ſame thing will be obſerved in the falx, if we cut the tentorium.

The ſmall occipital ſeptum is both very ſhort and narrow. It runs down from the middle of the tranſverſe ſeptum to the edge of the great occipital hole, being fixed to the internal ſpine of the os occipitis. It is formed by a fold and duplicature of the internal part of the dura mater, in the ſame manner as the other two, and it diſtinguiſhes the lower part of the occipital cavity of the cranium into two lateral parts. In ſome ſubjects this ſeptum is double, anſwering to the double ſpine of the os occipitis.

Sphenoidal folds. Beſides theſe large folds, there are two ſmall lateral ones on each ſide of the cella turcica, each running from the poſterior to the anterior clinoid apophyſis on the ſame ſide. Theſe two folds, together with the anterior or poſterior parts of the cella turcica, form a ſmall foſſula, in which the pituitary gland is lodged. There are likewiſe two anterior folds at the edges of the ſphenoidal or ſuperior orbitary fiſſures, which augment the depth of the middle foſſulae of the baſis cranii. Thus we have ſeven folds of this membrane, three large and four ſmall, which may be termed *internal productions* or *proceſſes of the dura mater.*

Elongations. The elongations of the dura mater go beyond the general circumference, and paſs out of the cranium, through the openings deſcribed in the treatiſe of the ſkeleton, and may be named *external productions of the dura mater.*

The moſt conſiderable of theſe elongations paſſes through the great occipital foramen, and runs down the common canal of the vertebrae, in form of a tube, lining the inſide of that canal, and incloſing the medulla ſpinalis, by the name of the *dura mater* of that medulla. The other elongations accompany the nerves out of the cranium in form of vaginae, which are more numerous than the nervous trunks reckoned in pairs. For the olfactory nerves, there is the ſame number

of

of diſtinct vaginae as there are holes in the lamina ethmoidalis; and ſome nerves, as the ninth pair, are accompanied by ſeveral vaginae through one hole.

There are two particular elongations which form the perioſteum of the orbits, together with the vaginae of the optic nerves. Theſe orbitary elongations go out by the ſuperior orbitary fiſſures, or foramina lacera of the ſphenoid bone; and, increaſing in breadth in their paſſage, line the whole cavity of the orbits, at the edges of which they communicate with the pericranium and perioſteum of the face. They communicate likewiſe, through the ſpheno-maxillary or inferior orbitary fiſſures, with the pericranium of the temporal and zygomatic foſſae: and by theſe communications we may explain the accidents which happen to theſe parts in wounds of the head.

The elongations of the dura mater, which accompany the blood-veſſels through the foramina of the cranium, unite with the pericranium immediately afterwards. Such, for inſtance, are the elongations which line the foſſulae of the foramina lacera or jugularia, and the bony or carotid canals of the apophyſis petroſa, &c.

Arteries. The veſſels of the dura mater are arteries, veins, and ſinuſes. The arteries, in general, are diſtinguiſhed into anterior, middle, and poſterior, and come from the carotids and vertebrales on each ſide. The external carotid ſends a branch through the ſpinal hole of the os ſphenoidale, which is the middle artery of the dura mater; and is called, by way of eminence, *arteria durae matris.* It is divided into a great number of branches, which are plentifully diſperſed through the ſubſtance of the external lamina as high as the falx, where theſe ramifications communicate with their fellows from the other ſide. The impreſſions of this artery are ſeen on the inſide of the parietal bones; the anterior and lower angle of which, inſtead of a ſimple impreſſion, contains a canal

canal for the paſſage of a trunk or branch of this artery; on which account ſeveral accidents happen in fractures of the ſkull.

The external carotid ſends another ſmall ramus through the corner or ſmall end of the ſphenoidal or ſuperior orbitary fiſſure, where there is ſometimes a little notch on purpoſe, as was mentioned in the deſcription of the ſkeleton. This branch is the anterior artery of the dura mater; and it gives off ramifications in the ſame manner as the former, with which it communicates, but its ramifications are not ſo numerous. The internal carotid, as it enters the cranium, gives off a ſmall branch to the ſubſtance of the dura mater.

The two vertebral arteries enter by the great occipital foramen, and unite in one trunk on the anterior or ſphenoidal apophyſis of the os occipitis. Immediately after they paſs through the dura mater on both ſides, each of them ſends one or two branches to that membrane. Theſe are the poſterior arteries of the dura mater; and they communicate by ſome ramifications with the middle or ſpinal artery above mentioned.

Veins and ſinuſes. The dura mater contains in its duplicature ſeveral particular canals, into which the venous blood, not only of that membrane, but of the whole brain, is carried. Theſe canals are termed *ſinuſes*; and ſome of them are diſpoſed in pairs, others in uneven numbers; that is, ſome of them are placed alone in a middle ſituation; others are diſpoſed laterally on each ſide of the brain. The moſt ancient anatomiſts reckoned only four, to which we can now add ſeveral others.

Theſe ſinuſes are in the duplicature of the dura mater; and their cavities are lined on the inſide by particular very fine membranes. They may be enumerated in this manner: The great ſinus of the falx, or ſuperior longitudinal ſinus, which was reckoned the firſt by the ancients. Two great lateral

lateral ſinuſes, the ſecond and third of the ancients. The ſinus called *torcular Herophili*, the fourth of the ancients. The ſmall ſinus of the falx, or inferior longitudinal ſinus. The poſterior occipital ſinus, which is ſometimes double. Four ſinus petroſi; two on each ſide, one ſuperior, and one inferior. Two tranſverſe occipital ſinuſes. The circular ſinus of the ſella ſphenoidalis. Two ſinus cavernoſi, one on each ſide. Two orbitary ſinuſes, one on each ſide.

All theſe ſinuſes communicate with each other, and with the great lateral ſinuſes, by which they diſcharge themſelves into the internal jugular veins, which are only continuations of theſe lateral ſinuſes. They likewiſe unload themſelves, partly into the vertebral veins, which communicate with the ſmall lateral or inferior occipital ſinuſes; and partly into the external jugular veins, by the orbitary ſinuſes, which communicate with the venae angulares, frontales, naſales, maxillares, &c. as the lateral ſinuſes likewiſe communicate with the venae occipitales, &c.

Thus the blood, which is carried to the dura mater, &c. by the external and internal carotid, and by the vertebral arteries, is returned to the heart by the external and internal jugular and vertebral veins; ſo that the blood, if obſtructed in one place, finds, in conſequence of theſe communications, a paſſage at another, though perhaps not with the ſame eaſe. This obſervation is of conſequence, in relation not only to obſtructions, but to the different ſituations of the head.

The great ſinus of the falx reaches from the connection of the ethmoidal criſta with the os frontis, along the upper edge of the falx, all the way to the poſterior edge of the tranſverſe ſeptum, where it ends by a bifurcation in the great lateral ſinuſes. It is very narrow at its anterior extremity, and from thence becomes gradually wider all the way to its poſterior extremity.

The cavity of this ſinus is not cylindrical, but triangular, having three ſides; one ſuperior, parallel to the cranium; and two lateral, inclined to the plane of the falx. The upper ſide is formed by the external ſurface of the dura mater; and, through the middle of its breadth, a kind of fine raphe or ſuture runs from one end to the other.

The two lower or lateral ſides are productions of the inner ſurface of the dura mater; which having parted from the external, are inclined towards each other, and then unite; forming firſt the ſinus, and afterwards the duplicature of the falx. This ſinus is lined interiorly by a fine proper membrane, which forms likewiſe a kind of raphe or ſuture along the bottom of the ſinus, that is, along the union of the two lateral ſides.

In this ſinus we obſerve ſeveral openings and ligamentary fraena. The openings are orifices of veins; the ſmalleſt of which belong to the dura mater, the largeſt to the brain. The veins of the brain enter the ſinus, for the moſt part, obliquely from behind forward, after they have run about a finger's breadth in the duplicature of the dura mater.

It has been thought, that the arteries of the dura mater diſcharged themſelves immediately into the ſinuſes; becauſe injections made by the arteries, or a hog's briſtle thruſt into them, have been found to paſs into theſe ſinuſes: But, on a more cloſe examination, it has been diſcovered, that the injection paſſed from the arteries into the veins, and from thence into the ſinuſes, through the ſmall orifices already mentioned; and that the hog's briſtle pierced the ſides of the artery, which are very thin near the ſinuſes.

This miſtake gave riſe to another, namely, that the dura mater had no veins; and what confirmed it was, that the arteries of the dura mater cover the veins ſo entirely, that the edges of the veins are hardly perceivable on either ſide of the arteries. There are, however, ſome places where the veins

veins being broader than the arteries, their two edges are ſeen on each ſide of the arteries like capillary veſſels. Theſe veins are, for the moſt part, branches of the ſinuſes, and the ſmall trunks of ſome of them open into the head of the vena jugularis interna. We may eaſily be ſatisfied that the arteries on both ſides of the dura mater communicate with each other above the falx, either by injecting or blowing into them.

The internal fraena of this great ſinus appear to be tendinous, and to be deſigned to prevent the too great dilatation of the ſinus by the blood. They vary, however, in different ſubjects, and do not always reach from one ſide to the other. It has been pretended, that glands have been found there; but we ought to take care that ſome ſmall corpuſcles, which ſeem to poſſeſs little or no glandular nature, are not miſtaken for glands.

The inferior ſinus of the falx is ſituated in the lower edge of its duplicature, being very narrow, and, as it were, flatted on both ſides. It communicates immediately with the fourth ſinus of the ancients, and in ſome ſubjects ſeems even to be a continuation of it. It likewiſe communicates with the great or ſuperior ſinus by ſmall veins, which go from one to the other, and with the veins of the cerebrum by the ſame means.

The lateral ſinuſes repreſent two large branches of the ſuperior longitudinal ſinus, one going to the right hand, the other to the left, along the great circumference of the tranſverſe ſeptum, all the way to the baſis of the apophyſis petroſa of the oſſa temporum. From thence they run down, having firſt taken a large turn, and then a ſmall one; and being ſtrongly fixed in the lateral grooves of the baſis cranii, they follow its courſe all the way to the foramina lacera and foſſulae of the jugular veins.

They do not always riſe by an equal bifurcation of the ſuperior longitudinal ſinus; for, in ſome ſubjects, one of the lateral

lateral ſinuſes appears to be a continuation of the longitudinal, and the other to be a branch from it. This variety may happen on either ſide; and we ſometimes find one of theſe ſinuſes higher or lower, larger or ſmaller, than the other.

The cavity of theſe lateral ſinuſes is likewiſe triangular, and furniſhed with a proper membrane and with fraena: And it has alſo the ſmall venal openings, which indeed are common to it, the longitudinal, and moſt other ſinuſes. The poſterior, or outer ſide of this cavity, is formed by the external part of the dura mater, and the other two ſides by the internal part.

As theſe two ſinuſes go out by the poſterior portions of the openings of the baſis cranii, called *foramina lacera*, they are dilated into a kind of bag, proportioned to the foſſulae of the venae jugulares, where they terminate in theſe veins.

Near the concourſe of the ſuperior longitudinal and lateral ſinuſes, we obſerve an opening (ſometimes double) which is the orifice of a ſinus ſituated along the union of the falx and tranſverſe ſeptum. It does not always end directly at the lower part of the ſuperior ſinus, but ſometimes opens at the beginning of one of the lateral ſinuſes, eſpecially when the bifurcation is not equal; and, in this caſe, it often terminates in that lateral ſinus, which appears like a branch from the common trunk of the ſuperior and other lateral ſinus.

This ſinus has been named *torcular Herophili*, from an ancient author, who imagined that the blood was as it were in a preſs, at the union of theſe four ſinuſes. Its diameter is but ſmall, and it forms a kind of bifurcation with the inferior longitudinal ſinus, and with a vein of the cerebrum, which is ſometimes double, called *vena magna Galeni*.

The cavernous or lateral ſinuſes of the os ſphenoides, are reſervatories of a very particular kind, containing not only blood, but conſiderable veſſels and nerves, as we ſhall ſee hereafter; and likewiſe a ſpongy or cavernous ſubſtance, full

of

of blood, much like that of the corpus cavernoſum of the urethra.

Nerves and glands. We obſerve ſome nervous filaments, which appear to go to the dura mater from the trunk of the fifth pair, at the entry of the cavernous ſinus; and from the common trunk of the eighth pair and nervus acceſſorius or ſpinalis, as they paſs through the foramen lacerum. Inflammation, as well as ſurgical phenomena, ſhew that the dura mater is not void of ſenſibility, though, in the ſound ſtate, this is not very obvious. The ſmall tubercles, found on the lateral ſides of the longitudinal ſinus of the falx and contiguous parts of the brain, deſerve ſtill to be examined before we can determine any thing about them: They have been called *glands* by Pacchioni, and ſeem to belong rather to the conglomerate than to the conglobate kind. The whole inſide of the dura mater is moiſtened in the ſame manner as the peritonaeum and pleura.

The prominent fibres which appear interſecting each other in different manners on the inſide of the dura mater, eſpecially near the falx and tranſverſe ſeptum, and which have been taken for a kind of fleſhy fibres, ſeem to be only ligamentary and elaſtic. The univerſal adheſion of this membrane to the cranium, proves that it can have no particular motion, and conſequently, that ſuch fleſhy or muſcular fibres would be altogether uſeleſs. This adheſion was plainly demonſtrated by Veſalius, Riolan, &c. long before Roonhuyſen.

§ 2. *Pia Mater.*

Situation in general. This membrane is a much ſofter and finer ſubſtance than the former, being exceedingly delicate, tranſparent, and vaſcular; and is connected to the dura mater only by the veins which open into the ſinuſes, as has been already ſaid.

Structure.

Structure. It is compoſed of two laminae, of which the external one is named *tunica arachnoidea*, from its reſemblance to a cobweb. They adhere cloſely to each other at the upper part of the brain; but are eaſily ſeparable at the baſis, and through the whole length of the ſpinal marrow.

The tunica arachnoidea is a remarkable thin and tranſparent membrane, having no veſſels, that can be injected, entering into its compoſition. It is ſpread uniformly over the ſurface of the brain, incloſing all the circumvolutions, but without entering in between any of them; while the pia mater forms a great number of plicae, duplicatures, and ſepta, which not only cover the brain in general, but inſinuate themſelves into all the folds and circumvolutions, and between the different ſtrata of the cerebrum and cerebellum, and are likewiſe continued into the different cavities.

The two laminae of the pia mater are connected by a cellular ſubſtance, which accompanies them through their whole extent, except at ſome places of the baſis of the cerebrum, &c. where, the internal lamina continuing its inſertions, the external remains uniformly ſtretched over the prominent parts, the interſtices of which are entirely ſeparated from the other lamina, without any cellular ſubſtance between them. Theſe ſeparate portions of the external lamina have made it be looked upon as a third membrane of the brain, diſtinct from the pia mater.

§ 3. *Cerebrum.*

Situation and figure. The cerebrum, properly ſo called, is a kind of medullary maſs, of a moderate conſiſtence, and of a greyiſh colour on the outer ſurface, filling all the ſuperior portion of the cavity of the cranium, or that portion which lies above the tranſverſe ſeptum. The upper part of the cerebrum is of an oval figure, like half an egg cut lengthwiſe,

or

or rather like two quarters of an egg cut lengthwiſe, and parted a little from each other. It is flatter on the lower part, each lateral half of which is divided into three eminences, which correſpond with the cavities at the baſe of the cranium.

Diviſion and lobes. The cerebrum is divided into two lateral portions, ſeparated by the falx, or great longitudinal ſeptum of the dura mater. They are generally termed *hemiſpheres*, but they are more like quarters of an oblong ſpheroid. Each of theſe portions is divided into two extremities, one anterior, and one poſterior, which are termed the *lobes of the cerebrum*, between which there is a large inferior protuberance which goes by the ſame name; ſo that in each hemiſphere there are three lobes, one anterior, one middle, and one poſterior.

The anterior lobes lie upon thoſe parts of the os frontis which contribute to the formation of the orbits and of the frontal ſinuſes, commonly called the *anterior foſſae of the baſis cranii.* The middle lobes lie in the middle or lateral foſſae of the baſis cranii; and the poſterior lobes on the tranſverſe ſeptum of the dura mater. The anterior and middle lobes of the cerebrum, on each ſide, are parted by a deep narrow ſulcus, which aſcends obliquely backward, from the temporal ala of the os ſphenoides to near the middle of the os parietale; and the two ſides of this diviſion have each their particular ridges and convolutions, which gives a very great extent to the cortical ſubſtance. This ſulcus is termed *fiſſura magna Sylvii*, or ſimply *fiſſura cerebri.*

Sides and inequalities. Each lateral portion of the cerebrum has three ſides; one ſuperior, which is convex; one inferior, which is uneven; and one lateral, which is flat, and turned to the falx. Through the whole ſurface of theſe three ſides we ſee inequalities or windings, like the circumvolutions of inteſtines, formed by weaving ſtreaks or furrows, very deep

and

and narrow, into which the ſepta or duplicatures of the pia mater inſinuate themſelves, and thereby ſeparate theſe circumvolutions from each other.

Near the ſurface of the cerebrum, theſe circumvolutions are at ſome diſtance from each other, repreſenting ſerpentine ridges; and, in the interſtices between them, the ſuperficial veins of the cerebrum are lodged, between the two laminae of the pia mater, from whence they paſs into the duplicature of the dura mater, and ſo open into the ſinuſes.

Theſe circumvolutions are fixed through their whole depth to the ſepta or duplicatures of the pia mater, by an infinite number of very fine vaſcular filaments, as may be ſeen by pulling the circumvolutions a little aſunder with the fingers.

When we cut tranſverſely, we obſerve that the ſubſtantia alba lies not only in the inner part of the brain in general, but alſo within each circumvolution, ſo that there is the ſame number of internal medullary circumvolutions as of external cortical ones; the firſt repreſenting white lammae inveſted by others of an aſh colour; but the cortical ſubſtance is in many places thicker than the medullary.

Subſtance. The ſubſtance of the cerebrum is of two kinds, diſtinguiſhed by two different colours; one part of it being of a greyiſh or aſh colour; the other, which is ſomewhat firmer than the former, is remarkably white, but redder in the foetus. The aſh coloured ſubſtance lies chiefly on the outer part of the cerebrum like a kind of cortex, from whence it has been named *ſubſtantia corticalis*, or *cinerea*. The white ſubſtance occupies the inner part, and is named *ſubſtantia medullaris*, or ſimply *ſubſtantia alba*. This abounds in greater quantity than the other, and in many places is perforated with red arteries.

Corpus callofum. Having cut off the falx from the criſta galli, and turned it backward, if we ſeparate gently the two lateral parts or hemiſpheres of the cerebrum, we ſee a longitudinal

tudinal portion of a white convex body, which is named *corpus callosum*. It is a middle portion of the medullary substance, which, under the inferior sinus of the falx, and also a little towards each side, is parted from the mass of the cerebrum, to which it is simply contiguous, from one end of that sinus to the other; so that, at this place, the edge of the inside of each hemisphere only lies on the corpus callosum, much in the same manner as the anterior and posterior lobes lie on the dura mater. Both extremities of this medullary body terminate by a small edge bent transversely downward.

The surface of the corpus callosum is covered by the pia mater, which runs in between the lateral portions of this body and the lower edge of each hemisphere. Along the middle of its surface, from one end to the other, a kind of raphe is formed, by a particular intertexture of fibres crossing each other. This raphe is made more perceivable by two small medullary cords, which accompany it on each side, and adhere closely to the transverse fibres. The same striated appearance is to be observed in the inner parts of this substance.

Medullary arch, and centrum ovale. The corpus callosum becomes afterwards continuous on each side with the medullary substance; which, through all the remaining parts of its extent, is entirely united with the cortical substance, and, together with the corpus callosum, forms a medullary arch or vault of an oblong or oval figure. To perceive this, the whole cortical substance, together with the medullary laminae mixed with it, must be cautiously and dexterously cut in the same direction with the convexity of the cerebrum; after which we observe a medullary convexity, much smaller than that which is common to the whole cerebrum, but of the same form; so that it appears like a medullary nucleus of the cerebrum, especially when we consider it together with the medullary substance of the inferior part or basis of the cerebrum; for the deeper we go, the medullary part becomes

the broader. From thence M. Vieuſſens took occaſion to name this nucleus the *centrum ovale*.

Ventriculi laterales. Under this arch are two lateral cavities, much longer than they are broad, and very ſhallow, ſeparated by a tranſparent medullary ſeptum; of which hereafter. Theſe cavities are generally named *the anterior ſuperior ventricles of the cerebrum*, to diſtinguiſh them from two other ſmaller cavities which are ſituated more backward, as we ſhall ſee preſently; but the name of *lateral* or *great ventricles*, given them by Steno, is more proper than either of the other two.

The lateral ventricles are broad, and rounded at thoſe extremities which lie next the tranſparent ſeptum. They go from before backward, contracting in breadth, and gradually ſeparating from each other in their progreſs. Afterwards they bend downward, and run obliquely from behind forward, in a courſe like the turning of a ram's horn, and terminate almoſt under their ſuperior extremities, only a little more backward and outward.

At the poſterior part where they begin to bend downward, a particular elongation runs backward on each ſide, and terminates in a triangular pointed cavity, turned a little inward, the two points reſembling horns. Theſe ventricles are every where lined with a continuation of the pia mater.

Septum lucidum. The tranſparent partition, or *ſeptum lucidum*, as it is commonly called, lies directly under the raphe or future of the corpus calloſum, of which it is a continuation and a kind of duplicature. It is made up of two medullary laminae, more or leſs ſeparated from each other by a narrow medullary cavity, ſometimes filled with a ſerous ſubſtance. This cavity, in ſome ſubjects, reaches a great way backward, and ſeems to communicate with the third ventricle; and, as well as the other cavities of the brain, has been found full of water, in caſes of internal hydrocephalus.

Fornix.

Fornix. The ſeptum lucidum is united, by its lower part, to the anterior portion of that particular medullary body, called improperly *the fornix* with three pillars, becauſe of ſome reſemblance it is thought to bear to the arches of ancient vaults. It is, in reality, nothing but the corpus calloſum; the lower ſide of which is like a hollow ceiling with three angles, one anterior, and two poſterior; and three edges, two lateral, and one poſterior. The lateral edges are each terminated by a large ſemi-cylindrical border, like two arches, which uniting at the anterior angle, form by their union what is called *the anterior pillar of the fornix;* and, as they run backward ſeparately toward the two poſterior angles, they have then the name of *the poſterior pillars.*

The anterior pillar being double, is larger than either of the poſterior; and the marks of this duplicity always remain. Immediately below the baſis of this pillar, we obſerve a large, white, ſhort, medullary rope, ſtretched tranſverſely between the two hemiſpheres, and commonly called *the anterior commiſſure of the cerebrum.* It is to this pillar that the ſeptum lucidum adheres. The poſterior pillars are bent downward, and continued through the lower portions of the ventricles all the way to their extremities, reſembling a ram's horn, which is a name that has been given to them. They gradually diminiſh in thickneſs during this courſe; and at their outſides they have each a ſmall, thin, flat, collateral border, to which the name of *corpora fimbriata* is applied.

The poſterior pillars of the crura of the fornix unite with two medullary protuberances, called *pedes hippocampi.* The inferior ſurface of the triangular ceiling, which lies between theſe arches, is full of tranſverſe, prominent medullary lines; for which reaſon the antients called it *pſalloides* and *lyra*, comparing it to a ſtringed inſtrument, ſomething like what is now called a *dulcimer.*

Under

Under the fornix, and immediately behind its anterior crura, there is a hole of a conſiderable ſize, by which the two lateral ventricles communicate (*See* Monro on the Nervous Syſtem, Tab. IV.); and another paſſage leads down from this, under the different appellations of *foramen commune anterius*, *vulva*, *iter ad infundibulum*, but more properly *iter ad tertium ventriculum*.

Eminences. The fornix being cut off and inverted, or quite removed, we ſee firſt of all a vaſcular web, called *plexus choroides*, and ſeveral eminences more or leſs covered by the expanſion of that plexus. There are four pairs of eminences which follow each other very regularly, two large and two ſmall. The firſt two great eminences are named *corpora ſtriata*; and the ſecond, *thalami nervorum opticorum*. The four ſmall eminences are cloſely united together, the anterior being called *nates*, and the poſterior *teſtes*; but it would be better to call them ſimply *anterior* and *poſterior tubercles*. Immediately before theſe tubercles there is a ſingle eminence, called *glandula pinealis*.

Corpora ſtriata. The corpora ſtriata got that name, becauſe in cutting them with the knife we meet with a great number of white and aſh-coloured lines alternately diſpoſed, which are only the tranſverſe ſection of the medullary and cortical laminae mixed together in a vertical poſition in the baſis of the cerebrum, as appears evidently by inciſions made from above downward. Theſe two eminences are of a greyiſh colour on the ſurface, oblong, roundiſh, pyriform, and larger on the fore than on the back part, where they are narrow and bent.

They lie in the bottom of the ſuperior cavity of the lateral ventricles, which they reſemble in ſome meaſure in ſhape, their anterior parts being near the ſeptum lucidum, from which they gradually ſeparate as they run backward, and diminiſh in ſize. They are in reality the convex bottoms of

the

the ventricles; and it is at the lower part of the interſtice, between the largeſt portions of them, that we obſerve the greateſt tranſverſe cord, named *the anterior commiſſure of the cerebrum*, which we mentioned already in deſcribing the anterior pillar of the fornix calloſus. This cord communicates more particularly with the bottom of the corpora ſtriata, by a turn toward each ſide.

Thalami nervorum opticorum. The thalami nervorum opticorum are ſo named, becauſe theſe nerves ariſe chiefly from them. They are two large eminences placed by the ſide of each other, between the poſterior portions or extremities of the corpora ſtriata. Their figure is hemiſpheroidal and a little oval, and they are of a whitiſh colour on the ſurface; but their inner ſubſtance is partly greyiſh and partly white, ſo that, in cutting them, we ſee ſtreaks of different colours like thoſe of the corpora ſtriata.

Theſe two eminences are cloſely joined together; and at their convex part they are ſo far united, as really to become one body, the whitiſh outer ſubſtance being continued uniformly over them both.

At the bottom theſe two eminences are elongated downward toward both ſides, into two thick, round, whitiſh cords, which ſeparate from each other like horns, by a large curvature; and afterwards, by a ſmall curvature turned forward in an oppoſite direction to the former, and repreſenting the tip of an horn, they approach each other again. The ſize of theſe nerves diminiſhes gradually from their origin to their anterior re-union. We ſhall have occaſion to mention them more particularly in ſpeaking of the optic nerves.

Third ventricle. Immediately under the union or beginning of the thalami nervorum opticorum, lies a particular cavity called the *third ventricle* of the cerebrum. This cavity communicates at its upper and fore-part with the paſſage between the two lateral ventricles, and ſends down from its under

der and fore-part a paſſage through the infundibulum. It opens backwards into the paſſage called *iter ad quartum ventriculum.*

Infundibulum. Between the baſis of the anterior pillar of the fornix, and the anterior part of the union of the optic thalami, lies a ſmall medullary canal, named *infundibulum.* It runs down towards the baſis of the cerebrum, gradually contracting, and terminates by a ſmall membranous and ſtraight canal, in a ſoftiſh body ſituated in the ſella turcica, named *glandula pituitaria.*

Plexus choroides. The plexus choroides is a very fine vaſcular texture, conſiſting of a great number of arterial and venal ramifications, partly collected in two looſe faſciculi, which lie on each lateral ventricle, and partly expanded over the neighbouring parts, and covering in a particular manner the thalami nervorum opticorum, glandula pinealis, tuberculа quadrigemina, and the other adjacent parts both of the cerebrum and cerebellum, to all which it adheres.

In each lateral portion of this plexus, we obſerve a venal trunk, the ramifications of which are ſpread through the whole extent of the two portions. Near the glandula pinealis theſe two trunks approach each other, and, uniting behind that gland, they open into the torcular or fourth ſinus of the dura mater. When we blow into one of theſe trunks towards the plexus, the air paſſes into all its ramifications; and, in ſome ſubjects, theſe two veins form one trunk, which opens into the ſinus.

The ventricular or looſe portions of the plexus often appear to contain a great number of tubercles like glands, which, in the natural ſtate, are extremely ſmall, but grow bigger in diſeaſes. To be able to examine them as we ought, the looſe portions muſt be made to ſwim in clear water, and be there carefully expanded. By the help of a microſcope we then

ſee

ſee theſe tubercles in the natural ſtate, like ſmall folliculi, or little bags, more or leſs flatted.

Beſides this vaſcular web, or plexus of the ſeptum lucidum, the ſides of the fornix, of the eminences, ventricles, canals, and infundibulum, are all covered by a very fine membrane, in which, by injections or inflammations, we diſcover a great number of very fine veſſels. This membrane is in a manner a continuation of the plexus, and that ſeems to be a detachment from the pia mater. By the ſame means we likewiſe diſcover an extremely thin membrane on the inſides of the duplicature of the ſeptum, though, in ſome ſubjects, theſe ſides touch each other.

Glandula pituitaria The pituitary gland is a ſmall ſpongy body lodged in the cella turcica between the ſphenoidal folds of the dura mater. It is a ſingular kind of ſubſtance, and ſeems to be neither medullary nor glandular. On the outſide it is partly greyiſh and partly reddiſh, but white within. It is tranſverſely oval or oblong; and on the lower part, in ſome ſubjects, it is divided by a ſmall notch into two lobes, like a kidney bean. It is covered by the pia mater as by a bag, the opening of which is the extremity of the infundibulum; and it is ſurrounded by the ſmall circular ſinuſes which communicate with the ſinus cavernoſi.

Tubercula. The tubercles are four in number, two anterior and two poſterior, adhering together as if they made but one body ſituated behind the union of the thalami nervorum opticorum. They are tranſverſely oblong, the anterior being a little more rounded, and broader or larger from before backward, than the poſterior. Their ſurface is white, and their inner ſubſtance greyiſh. The names of *nates* and *teſtes*, given by the antients to theſe tubercles, are not very proper, there being little reſemblance between them and the things from which the names are taken. Some of the moderns, with perhaps ſtill leſs propriety, have called them *tubercula quadrigemina*,

quadrigemina. We ſhall uſe the names, however, as we find them.

Directly under the place where the tubercles of one ſide are united to thoſe of the other ſide, lies the *iter ad quartum ventriculum*, which communicates, by its anterior opening, with the third ventricle, under the thalami nervorum opticorum, and, by its poſterior opening, with the fourth ventricle, which belongs to the cerebellum.

Foramen commune poſterius. Where the convex parts of the two anterior tubercles join theſe poſterior convex parts of the thalami nervorum opticorum, an interſtice or opening is left between theſe four convexities; but it does not communicate with the third ventricle, for the bottom of it is ſhut up by the pia mater. The name of *anus* is applied to it.

Glandula pinealis. The glandula pinealis is a ſmall ſoft greyiſh body, about the ſize of an ordinary pea, irregularly round, and ſometimes of the figure of a pine apple, ſituated behind the thalami nervorum opticorum above the tubercula quadrigemina. It is fixed like a ſmall button to the lower part of the thalami, by two very white medullary pedunculi, which, at the gland, are very near each other, but ſeparate almoſt tranſverſely toward the thalami.

It ſeems to be moſtly of a cortical ſubſtance, except near the foot ſtalks, where it is ſomewhat medullary. The foot-ſtalks are ſometimes double, as if they belonged to the two anterior tubercles. This body adheres very cloſe to the plexus choroides, by which it is covered, as we ſhall ſee hereafter; and it therefore requires ſome dexterity to ſeparate it from the glandula, without altering its ſituation, or breaking the pedunculi. This gland has been often found to contain gravel. Below the glandula pinealis there is a medullary tranſverſe cord, called the *poſterior commiſſure of the hemiſpheres of the cerebrum.*

§ 4.

§ 4. *Cerebellum.*

Situation and figure. The cerebellum is contained under the tranſverſe ſeptum of the dura mater, in the under and back part of the cranium. It is broader laterally than on the fore or back ſides, flatted on the upper ſide, and gently inclined both ways, anſwerable to the ſeptum, which ſerves it as a kind of tent or ceiling. On the lower ſide it is rounder; and on the back ſide it is divided into two lobes, ſeparated by the occipital ſeptum of the dura mater.

Structure. It conſiſts, like the cerebrum, of two ſubſtances. It has no circumvolutions on its ſurface; but, inſtead of them numerous ſulci, which are deep, and diſpoſed in ſuch a manner as to form thin flat ſtrata, more or leſs horizontal, between which the internal lamina of the pia mater inſinuates itſelf by a number of ſepta equal to that of the ſtrata.

Under the tranſverſe ſeptum, it is covered by a vaſcular texture, which communicates with the plexus choroides. It has two middle eminences, called *appendices vermiformes*; one anterior and ſuperior, which is turned forward; the other poſterior and inferior, which goes backward. There are likewiſe two lateral appendices, both turned outward. They are termed *vermiformes*, from their reſemblance to a large portion of an earth-worm.

Beſides the diviſion of the cerebellum into lateral portions, or into two lobes, each of theſe lobes ſeems to be likewiſe ſubdivided into three protuberances; one anterior, one middle or lateral, and one poſterior: They are not, in all ſubjects, equally diſtinguiſhed either by their convexity or limits; but they may always be diſtinguiſhed by the direction of their ſtrata, thoſe of the middle and anterior protuberance being leſs tranſverſe than the poſterior.

Fourth ventricle. When we ſeparate the two lateral portions or lobes, having firſt made a deep inciſion, we diſcover, firſt of all, the poſterior portion of the medulla oblongata, of which hereafter; and, in the poſterior ſurface of this portion, from the tubercula quadrigemina, all the way to the poſterior notch in the body of the cerebellum, and a little below that notch, we obſerve an oblong cavity, which is called the *fourth ventricle*; this terminates backward, like the point of a writing pen. Hence the under end of it is called *calamus ſcriptorius*.

At the beginning of this cavity we meet with a thin medullary lamina, which is looked upon as a valve between that canal and the fourth ventricle. A little behind this lamina, the cavity grows wider towards both ſides, and then contracts again to its firſt ſize. It is lined by a thin membrane, and ſeems often to be diſtinguiſhed into two lateral parts, by a kind of ſmall groove, from the valvular lamina to the point of the calamus ſcriptorius.

This membrane is a continuation of that part of the pia mater which lines the ſmall canal, the third ventricle, infundibulum, and the two great ventricles. To be able to ſee the fourth ventricle in its natural ſtate, in which it is narroweſt, it muſt be laid open while the cerebellum remains in the cranium; and, in order to that, the os occipitis muſt be ſawen very low down.

On each ſide of this ventricle, the medullary ſubſtance forms a trunk which expands itſelf in form of laminae through the cortical ſtrata. But here we find the medullary bearing a leſs proportion to the cortical than it does in the cerebrum. We diſcover theſe medullary laminae according to their breadth, by cutting the cerebellum in ſlices almoſt parallel to the baſis of the cerebrum; but, if we cut one lobe of the cerebellum vertically, the medullary ſubſtance will appear to be diſperſed in ramifications through the cortical ſubſtance.

ſtance. Theſe ramifications have been named *arbor vitae*; and the two trunks, from whence theſe different laminae ariſe, are called *pedunculi cerebelli*.

We cannot go on with the deſcription of the other middle parts of the baſis of the cerebellum, before that of the middle parts of the baſis of the cerebrum; becauſe theſe two parts are united, and jointly form the medulla oblongata. We ſhall only add here, that the ſtrata of both ſubſtances of the cerebellum are not always of the ſame extent in the ſame portions or protuberances of each lobe. This appears merely by viewing the convex or outer ſurface of the cerebellum; for there we ſee, at different diſtances, ſome cortical ſtrata ſhorter than others, and likewiſe that the extremities of the ſhort ſtrata gradually diminiſh in thickneſs, till they are quite loſt between two long ones.

If we make a ſmall hole in the external lamina of the pia mater, over one of the lobes of the cerebellum, without touching the inner lamina, and then blow into the cellular ſubſtance, connecting theſe two laminae, through a ſmall pipe introduced into the hole; the air will gradually ſwell that ſubſtance, and ſeparate the ſtrata more or leſs equally from each other through their whole extent; and we ſhall ſee at the ſame time the diſpoſition of all the membranous ſepta or duplicatures of the internal lamina of the pia mater, with the numerous diſtribution of the fine blood veſſels which run upon it, eſpecially after a lucky injection, or in an inflammatory ſtate of theſe membranes.

§ 5. *Medulla oblongata.*

The medulla oblongata is a medullary ſubſtance, ſituated from before backward, in the middle part of the baſes of the cerebrum and cerebellum, without any diſcontinuation, between the lateral parts of both theſe baſes; and therefore it may

may be looked upon as one middle medullary baſis, common to both cerebrum and cerebellum, by the reciprocal continuity of their medullary ſubſtances, through the great notch in the tranſverſe ſeptum of the dura mater; which common baſis lies immediately on that portion of the dura mater lining the baſis of the cranium. The medulla oblongata is therefore juſtly eſteemed to be a third general part of the whole maſs of the brain, or as the common production, or united elongation, of the whole medullary ſubſtance of the cerebrum and cerebellum.

It is extremely difficult, if not altogether impoſſible, to examine or demonſtrate it as we ought, in its natural ſituation; but we are obliged to do both on a brain inverted.

The lower ſide of the medulla oblongata, in an inverted ſituation, preſents to our view ſeveral parts, which are in general either medullary productions, trunks of nerves, or trunks of blood veſſels.

The chief medullary productions are theſe: the large or anterior branches of the medulla oblongata, which have likewiſe been named *crura anteriora*, *femora*, and *brachia medullae oblongatae*, and *pedunculi cerebri*: The tranſverſe protuberance, called likewiſe *proceſſus annularis* or *pons Varolii*: The ſmall or poſterior branches, called *pedunculi cerebelli*, or *crura poſteriora medullae oblongatae*: The extremity or cauda of the medulla oblongata, with two pairs of tubercles; one of which is named *corpora olivaria*, the other *corpora pyramidalia*; and to all theſe productions we muſt add a production of the infundibulum and two medullary papillae.

The great branches of the medulla oblongata are two very conſiderable medullary faſciculi; the anterior extremities of which are ſeparated, and the poſterior united, ſo that, taken together, they ſomewhat repreſent a Roman V. Theſe faſciculi are flat, much broader before than behind; their ſurfaces being compoſed of ſeveral longitudinal and diſtinctly prominent

prominent medullary fibres. Their anterior extremities ſeem to be loſt at the lower part of the corpora ſtriata; and it is for that reaſon that they are eſteemed the pedunculi of the cerebrum.

The tranſverſe annular, or rather ſemi-annular protuberance, is a medullary production, which ſeems at firſt ſight to ſurround the poſterior extremities of the great branches; but the medullary ſubſtance of the protuberance is in reality intimately mixed with that of the two former. Varolius, an ancient Italian author, viewing theſe parts in an inverted ſituation, compared the two branches to two rivers, and the protuberance to a bridge over them both; and from thence it has the name of *pons Varolii*. Its ſurface is tranſverſely ſtreaked, and is divided into two lateral parts by a very narrow longitudinal depreſſion, which does not penetrate into its ſubſtance. When we cut into the ſubſtance of the pons, we find much cortical ſubſtance within it, and this formed into ſtriae, which run in various directions. And the ſame thing will be found with reſpect to the medullary part of the brain; for there is ſcarcely any part of it but what has cortical ſtriae running through it.—See Monro's Obſervations on the Nervous Syſtem, Tab. VII.

The ſmall branches of the medulla oblongata are lateral productions of the tranſverſe protuberance, which by their roots ſeem to encompaſs that medullary portion in which the fourth ventricle or calamus ſcriptorius is formed. They form in the lobes of the cerebellum, on each ſide, thoſe medullary expanſions, a vertical ſection of which ſhews the white ramifications commonly called *arbor vitae*; and they may be juſtly enough ſtyled *pedunculi cerebelli*.

The extremity is no more than the medulla oblongata contracted in its paſſage backward to the anterior edge of the foramen magnum of the os occipitis, where it terminates in the medulla ſpinalis; and, in this part of it, ſeveral things are

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to be taken notice of. We ſee, firſt of all, four eminences, two named *corpora olivaria*, and the other two *corpora pyramidalia*. Immediately afterwards, it is divided into two lateral portions by two narrow grooves, one on the upper ſide, the other on the lower. They both run into the ſubſtance of the medulla, as between two cylinders, flatted on that ſide by which they are joined together.

When we ſeparate theſe ridges with the fingers, we obſerve a crucial intertexture of ſeveral ſmall medullary cords, which go obliquely from the ſubſtance of one lateral portion into the ſubſtance of the other. M. Petit, member of the Royal Academy of Sciences, and doctor of phyſic, is the author of this diſcovery, by which we are enabled to explain ſeveral phenomena, both in phyſiology and pathology; of which in another place.

The corpora olivaria and pyramidalia are whitiſh eminences, ſituated longitudinally near each other, on the lower ſide of the extremity or cauda, immediately behind the tranſverſe or annular protuberances. The corpora pyramidalia are in the middle; ſo that the interſtice between them, which is only a kind of ſuperficial groove, anſwers to the inferior groove of the following portion.

The corpora olivaria are two lateral eminences ſituated at the outſide of the former, and are thus termed by Willis, Duverney, Haller, &c. but Winſlow reverſes the names. Theſe four eminences are ſituated on the lower half of the medulla; which obſervation we here repeat, to make it be remembered, that, in all the figures and demonſtrations, theſe parts are repreſented as ſuperior, which, in their natural ſituation, are inferior. Thus theſe eminences are under the fourth ventricle, and under the pedunculi cerebelli.

The tubercula mammillaria, which are ſituated very near the production of the infundibulum, have been taken for glands; probably becauſe of their greyiſh inner ſubſtance, which,

which, however, does not ſeem to be different from that of ſeveral other eminences of the medulla oblongata. And, for that reaſon, we chooſe rather to call them, from their figure, *tubercula mammillaria*, than *papillae medullares*.

Theſe tubercles ſeem to have ſome immediate relation to the roots or baſis of the anterior pillar of the fornix; ſo that we might call them, as M. Santorini has done, *the bulbs of theſe roots*, though they appear to be likewiſe part of a continuation of other portions of the cortical and medullary ſubſtance, of a particular texture.

The beak or tube of the infundibulum is a very thin production from the ſides of that cavity; and it is ſtrengthened by a particular coat given to it by the pia mater. It is bent a little from behind forward, toward the glandula pituitaria, and afterwards expands again round this gland.

The membrana arachnoides, or external lamina of the pia mater, appears to be very diſtinctly ſeparated from the internal lamina, in the interſtices between all theſe eminences on the lower ſide of the medulla oblongata, without any viſible cellular ſubſtance between them. The internal lamina adheres much more to the ſurface of theſe interſtices than to that of the eminences. The external lamina is as it were buoyed up by the eminences, and equally ſtretched between their moſt prominent parts, to which it ſticks very cloſe; and in this reſpect the roots or great cornua of the optic nerves may be joined to theſe eminences.

We muſt obſerve in general concerning the eminences of the medulla oblongata, that thoſe which are medullary on their outſides or ſurfaces, are interiorly either entirely cortical, or partly cortical and partly medullary, or formed by a ſingular mixture of theſe two ſubſtances, which ſtill remains to be unfolded, as well as many other peculiarities obſervable in examining the internal ſtructure of the brain.

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From this common portion of the cerebrum and cerebellum, ariſe almoſt all the nerves which go out of the cranium, through the different foramina perforating its baſe. It likewiſe produces the medulla ſpinalis, which is no more than a common elongation of the cerebrum and cerebellum, and of their different ſubſtances; and therefore the medulla oblongata may juſtly be ſaid to be the firſt origin or primitive ſource of all the nerves which go out through the ſpina dorſi, and conſequently of all the nerves of the human body.

§ 6. *Medulla Spinalis.*

The medulla ſpinalis is only an elongation of the extremity of the medulla oblongata; and it has its name from its being contained in the bony canal of the ſpina dorſi. It is conſequently a continuation or common appendix of the cerebrum and cerebellum, as well becauſe of the two ſubſtances of which it is compoſed, as becauſe of the membranes by which it is inveſted.

In the deſcription of the freſh bones, mention was made of a ligamentary ſubſtance which lines the inner ſurface of this bony canal, from the great occipital foramen to the os ſacrum. Beſides this, the dura mater, after it has lined the whole internal ſurface of the cranium, goes out by the foramen magnum occipitis, and forms a kind of funnel, in its progreſs downward, through the bony canal of the vertebrae. As it goes out at the occipital hole, it joins the beginning of the ligamentary funnel already mentioned, and adheres very ſtrongly to it. That portion of the pericranium which terminates exteriorly at the edge of the great foramen, joins the funnel likewiſe, which, by all theſe acceſſions becomes very ſtrong, and capable of reſiſting the greateſt violences.

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This adhesion of the dura mater to the ligamentary funnel is gradually discontinued below the first vertebra; and from thence the dura mater forms a separate tube, which runs down the bony canal all the way to the os sacrum, the capacity of it answering to that of the canal; but it does not adhere closely to the sides, as it does to those of the cranium. It is surrounded by a slimy substance, which, near the lower end of the canal, resembles fat.

The spinal marrow consists of a cortical and medullary substance, as the cerebrum and cerebellum; but with this difference, that the ash-coloured substance lies within the other; and, in a transverse section of this medulla, the inner substance appears to be of the form of a horse shoe, the convex side being turned forward and the extremities backward.

The body of the medulla spinalis runs down to the bottom of the first vertebra of the loins, where it terminates in a point. The size of it is proportionable to that of the bony canal, so that it is larger in the vertebrae of the neck than those of the back. It is a little flatted on the fore and back parts, so that we may distinguish in it two sides, one anterior, the other posterior, and two edges. It is likewise seemingly divided into two lateral halves or cords by a groove, which runs along the middle of its anterior and posterior surfaces, being a continuation of those in the extremity of the medulla oblongata. The cords are applied closely together, but may be easily separated before as well as behind, till we come to their middle or deepest part, where they are joined together by a thin layer of cineritious substance passing from the one cord into the other.

Each lateral portion sends off from both the fore and back sides, between the grooves and the edges, at different distances, flat fasciculi of nervous filaments turned toward the nearest edge. The anterior and posterior fasciculi are separated from each other by the ligamentum denticulatum; then

paſſing outwards, they go through the dura mater by two diſtinct openings very near each other. Having penetrated the dura mater, the poſterior bundle forms a ganglion, from the oppoſite end of which the trunk comes out again, and is there joined by the anterior bundle.

The dura mater which inveſts the medulla, ſends out on each ſide the ſame number of vaginae, as there are ganglions and nervous trunks. Theſe vaginae are productions of the external lamina; the internal lamina, which is very ſmooth and poliſhed on the inſide, being perforated by two ſmall holes very near each other, where each vagina goes off, through which holes the anterior and poſterior faſciculi are tranſmitted, and, immediately after their paſſage through the internal part, they unite.

The triangular ſpaces left between the anterior and poſterior faſciculi and the edge of the medulla, are filled from one extremity to the other by an indented ligament very thin and ſhining, having the ſame number of indentations as there are pairs of faſciculi. It is cloſely connected by numerous threads to the pia mater at each ſide of the medulla, while the oppoſite ſide ſends out indentations, the greater number of which run tranſverſely, though others go obliquely upwards or downwards; and all of them, after being ſplit into threads, are fixed to the inner ſide of the dura mater. The under end of the ligamentum denticulatum, runs as far as the os coccygis, and is what authors have conſidered as the fortieth pair of nerves *; from whence it ſends filaments to the internal part of the dura mater, by which the anterior faſciculi are diſtinguiſhed from the poſterior.

The membrana arachnoides is here very diſtinct from the internal lamina of the pia mater: So that, by blowing through a hole made in the arachnoides, it will ſwell from one

* For this and the three preceding paragraphs, ſee Monro on the Nervous Syſtem, Tab. IX. X. XVII. &c.

one end to the other, like a tranſparent gut. The internal lamina, called in this place ſimply the *pia mater*, adheres very cloſely to the medulla ſpinalis, and ſends many productions and ſepta through its ſubſtance. If, by a hole made in the pia mater, we inflate the ſubſtance of one lateral portion of the medulla, the air penetrates through the whole of it, and the pia mater, which covers the other lateral portion, is ſeparated from it.

The membrana arachnoides adheres more cloſely to the pia mater at the lower, than at the upper part, being, as it were, ſuſpended by the indented ligament which runs along both edges of the medulla, and is fixed, as was mentioned above, by a filament, to the internal lamina of the dura mater in each interſtice between the nervous faſciculi. It alſo gives off elongations, in the ſame manner as the dura mater, to each nervous trunk or rope, as we ſhall ſee hereafter.

§ 7. *The Nerves of the Brain and Spinal Marrow, from their origin to their going out of the Cranium and Spine.*

The nerves ariſe either from the brain, medulla oblongata, or ſpinalis; and they go out in faſciculi diſpoſed in pairs. They may be divided into three claſſes, viz. nerves which paſs through the cranium, nerves immediately from the ſpinal marrow, and nerves from the brain and ſpinal marrow conjointly; to which laſt claſs the great ſympathetic nerve belongs. Ten pairs belong to the brain and medulla oblongata, of which nine go out through the foramina of the cranium, and the tenth ariſes from the extremity of this medulla as it paſſes through the great occipital-hole; and, laſtly, 29 pairs belong to the medulla ſpinalis, of which ſeven paſs through the lateral notches of the vertebrae cervicis, twelve through thoſe of the back, five through thoſe of the loins, and five through the anterior holes of the os ſacrum.

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We ſhall, at preſent, only make ſome particular obſervations on the nerves while they remain within the bones, and reſerve the deſcription of their courſe through the whole body to its proper place.

Nerves of the brain. The firſt pair of nerves that ariſe from the brain are the olfactory, anciently called *proceſſus mammillares.* Theſe are two very flat and ſoft medullary ropes, each ariſing firſt by medullary fibres from the outſide of the lower part of the corpora ſtriata, between the anterior and middle lobe, on each ſide of the cerebrum, and afterwards by another filament more internally; and laſtly, by a third, which is more poſterior and very long. They run under the anterior lobes of the cerebrum, being lodged in two ſuperficial grooves in the baſis of theſe lobes, and lying immediately on the dura mater, from the clinoid apophyſis to the os ethmoides.

They are firſt of all conſiderably incurvated from without inward or toward each other, and, having reached near the back-ſide of the os ethmoides, they run for a ſmall ſpace parallel to, and at ſome diſtance from, each other. Backward they are very thin; but their bulk gradually increaſes in their courſe forward toward each ſide of the criſta galli, where they terminate in elongated papillae, the ſubſtance of which appears to be ſofter and leſs white than that of the nerves, as Dr Soemmering hath beſt deſcribed in his book, *De Baſ. Enceph. et Orig. Nervor.* to which the reader is referred.

Theſe papillae lie on the two ſides of the lamina cribroſa, and ſend down a nervous filament through each hole of that lamina. At the ſame place, the dura mater ſends off the ſame number of vaginae, which inveſt and accompany the nervous filaments and their ramifications on the internal parts of the noſe.

We have already related the origin of the ſecond pair, or optic nerves, from the eminences called *thalami nervorum opticorum;*

ticorum; and we have deſcribed their great curvature, and traced them all the way to their re-union, which happens immediately before the ſuperior part of the glandula pituitaria, and conſequently before the beak or production of the infundibulum. The internal carotids run upon the outſides of theſe nerves, immediately after their union, and before they paſs through the foramina optica.

Beſides their origin from the optic thalami, theſe nerves have likewiſe a kind of communication with the tubercula quadrigemina anteriora, by very fine filaments; one extremity of which is loſt in the tubercles, the other in the roots of the great arches or bodies of the optic nerves. They are alſo connected with the crura cerebri. The internal ſtructure of theſe nerves ſeems to change at their entrance into the optic holes, as we ſhall ſee in another place.

The union of theſe nerves, by the ſmall curvatures of their cornua, is very difficult to be unfolded in human bodies. This union is commonly found to be very cloſe; but, in ſome ſubjects, it ſeems to be no more than a ſtrong adheſion; in others, to be partly made by an interſection or croſſing of fibres. They have indeed been found quite ſeparate; and in other ſubjects, one of them has been obſerved to be very much altered, both in ſize and colour, through its whole paſſage, the other remaining in its natural ſtate.

The third pair, called *nervi motores, oculi communes, oculares communes*, and *oculo-muſculares*, ariſe from the crura cerebri, between the corpora albicantia and a ſulcus that ſeparates the crura from the tuber annulare, by numerous threads collected into two bundles, the one a little longer than the other. Theſe ſoon unite into their reſpective trunks, which pierce the dura mater behind the lateral parts of the poſterior apophyſis of the ſella turcica, and paſs afterwards along the ſinus cavernoſi, by the ſide of the carotid artery, and all the way

to

to the broad portion of the ſuperior orbitary fiſſure, where they are divided in the manner to be afterward deſcribed.

The fourth pair, called *nervi trochleares, muſculares obliqui ſuperiores*, and moſt commonly *pathetici*, are very ſmall and tender, and, in proportion, very long. They ariſe each behind the teſtes by one, and ſometimes by two, ſmall threads. From thence they take their courſe forward all the way to the edge of the anterior extremities of the tentorium, a little to the outer ſide of the poſterior clinoid proceſs, where on each ſide they enter the duplicature of the dura mater, and advancing by the ſide of the ſinus cavernoſi, they accompany the third pair to the ſuperior orbitary fiſſure.

The fifth pair, called *nervi innominati*, or *trigemini*, are at firſt large trunks ariſing by two faſciculi from the outer and fore part of the crura cerebelli, where they join the tuber annulare a little before the ſeventh pair. They run down obliquely forward on the extremity of the upper or anterior ſide of the apophyſis petroſa, very near the ſide of the ſella ſphenoidalis, where they enter the duplicature of the dura mater and ſinus cavernoſi.

At their entry into the ſinus, they form a kind of flat irregular ganglion, from which ſome filaments are ſent off to the dura mater; and, immediately afterward, each of them is divided into three great branches, one ſuperior or anterior, one middle, and one inferior or poſterior. The firſt branch, which may be termed *ocularis* or *ophthalmicus*, accompanies the nerves of the third and fourth pairs through the foramen lacerum of the ſphenoid bone. The ſecond, called *maxillaris ſuperior*, goes out by the foramen rotundum; and the third, named *maxillaris inferior*, by the foramen ovale of the ſame bone. As the great trunk of this nerve runs down, it perforates the membrana arachnoides, which at this place forms a kind of ceiling.

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The fixth pair, named *motores oculorum externi*, *oculares* or *ophthalmici externi*, and *oculo muſculares externi*, are ſmall nerves, but ſtill not ſo ſmall as the fourth pair; and they have ſometimes been found double. They ariſe from a ſulcus between the back part of the tuber annulare and beginning of the medulla oblongata, and paſſing immediately under the tuber, they pierce the dura mater behind the occipital ſymphyſis of the ſphenoidal bone.

They run on each ſide in the duplicature of the dura mater to the cavernous ſinus; and having entered that ſinus, each of them croſſes the outſide of the internal carotid artery in their way to the foramen lacerum. In this courſe, they communicate with the firſt branch of the fifth pair, and by a filament or two, which ariſe from the great ſympathetic nerve, and run up with the carotid artery.

The ſeventh pair, named *auditorii*, are each divided into two portions; one, from its hardneſs, when compared with the other parts, is called *portio dura*, or *nervus ſympatheticus minor*. This ariſes from the ſpace where the crus cerebelli joins the tuber annulare. The other part is larger and ſofter than the former, and is called *portio mollis*, or the true *auditory nerve*. It ariſes from the inner ſurface of the fourth ventricle, and is afterwards joined by an intermediate portion deſcribed by Dr Wriſberg. The *portio mollis* is hollowed out to receive the portio dura, which accompanies it to the foramen auditorium internum.

The eighth pair ariſe from the poſterior extremities of the large branches or crura of the medulla oblongata, a little to the outer ſide of the corpora olivaria, by numerous filaments, which are collected into two bundles, one called *gloſſopharyngeum*, the other *par vagum*, or *nervus ſympatheticus medius*. This runs toward the foramen lacerum, where it pierces the dura mater, and goes out through the anterior part of that hole, having been firſt joined by a nervous portion that runs

up

up from the medulla ſpinalis through the great occipital foramen, by the name of *nervus acceſſorius octavi paris*, or *nervus ſpinalis*. This additional nerve goes out with that of the eighth pair through the foramen lacerum, lying behind it, but diſtinguiſhed from it by a membranous ſeptum.

The ninth pair, called *nervi hyppogloſſi externi*, *hyppogloſſi majores*, and commonly *guſtatorii*, ariſe each from the furrow that ſeparates the corpora olivaria and pyramidalia. Theſe branches ſoon unite into a trunk which paſſes through the anterior condyloid hole; ſometimes the branches form two trunks, which, after piercing the dura mater, unite and go through the hole above mentioned.

The tenth pair, called *nervi ſub-occipitales*, ariſe under the ninth pair, chiefly from the anterior, and a little from the lateral part of the extremity of the medulla oblongata, oppoſite to the poſterior part of the condyloid apophyſis of the occipital bone, by a ſingle plane or faſciculus of ſmall filaments which pierce the dura mater directly from within outward, at the ſame place where the vertebral arteries perforate it from without inwards. One or two threads frequently come from the back part of the medulla, and are at firſt ſeparated from the anterior bundle by the nervus acceſſorius and ligamentum denticulatum; but afterwards unite with it into one trunk.

Nerves of the medulla ſpinalis. The nerves formed by the lateral union of the anterior and poſterior filaments of the medulla ſpinalis, go out of the bony canal of the ſpina dorſi, towards each ſide, through the intervertebral holes, through the anterior holes of the os ſacrum, and the lateral notches of the os coccygis; and from thence they have the general name of *nervi vertebrales*. They are divided, in the ſame manner as the vertebrae, into ſeven pair of cervical nerves, twelve pair of dorſal, five pair of lumbar, and five pair of nervi ſacri.

As

As the ſpinal marrow which furniſhes all theſe nerves, ſeldom goes lower than the firſt or ſecond vertebra of the loins, the ſituation of the faſciculi of nervous filaments muſt be different from that of the holes through which they paſs; and ſeveral of theſe faſciculi, both anterior and poſterior, muſt be longer than the reſt. This we find from experience to by the caſe, in the following manner.

The faſciculi of nervous filaments of the medulla ſpinalis, which produce the cervical nerves, run more or leſs tranſverſely toward each ſide from their origin to their paſſage through the intervertebral holes. The faſciculi which form the dorſal nerves run a little obliquely downward from their origin to the intervertebral holes; and thoſe which form the lumbar nerves run down more and more longitudinally from the medulla to the holes by which they go out.

The cervical faſciculi therefore are very ſhort in the ſpinal canal; the dorſal faſciculi are longer, and the faſciculi from the loins and os ſacrum very long. It muſt likewiſe be obſerved, that the faſciculi of the four loweſt pairs of the cervical nerves, and firſt pair of the dorſal nerves, are broader and more compounded than the following, becauſe the brachial nerves are a continuation of theſe. The filaments belonging to the lumbar nerves, and thoſe of the os ſacrum, are likewiſe very broad, and made up of numerous filaments, as being the roots of the large nerves which go to the lower extremities. The dorſal filaments are very ſmall.

The cervical and lumbar faſciculi are not only broader, and conſiſt of more filaments than the dorſal, but alſo ſituated much cloſer to each other, the lumbar faſciculi being ſtill more ſo than the cervical: whereas in the dorſal a conſiderable interſtice is left between the faſciculi.

Theſe lumbar faſciculi, from their origin to the extremity of the os ſacrum, form, through the whole canal of the lumbar vertebrae and of the os ſacrum, a large bundle of nervous

ropes, called by anatomiſts *cauda equina*, becauſe of ſome reſemblance which it bears to a horſe's tail, eſpecially when taken out of the canal, and extended in clear water.

Though the medulla ſpinalis ends at the firſt vertebra of the loins, the vagina of the dura mater, by which it is inveſted, is continued through the reſt of the bony canal all the way to the extremity of the os ſacrum, and involves the great bundle or cauda equina, the cords of which pierce it on each ſide nearly oppoſite to the places where they paſs through the intervertebral holes, and the anterior holes of the os ſacrum, almoſt in the ſame manner as was ſaid above in deſcribing the general formation of the vertebral nerves.

After this vagina of the dura mater is detached from the ſpinal canal, by cutting the tranſverſe branches which go out of the intervertebral holes, it appears to have evident marks of elaſticity, for it immediately ſhrinks up, as an artery or other elaſtic ſtring would do, when cut acroſs. Therefore its true length muſt be taken while it is *in ſitu*, and likewiſe the true ſituation of the lateral elongations.

From all this, a concluſion may be drawn, of great importance, not only in anatomical and philoſophical inquiries, but alſo for underſtanding local diſeaſes, wounds, &c. which is, that, when we have occaſion to conſider any particular nerves near the vertebrae of the back or loins, or near the os ſacrum, we muſt remember that, in the ſpina dorſi, the origin of theſe nerves is not even with their paſſage out of the ſpine, but proportionally higher. If, for inſtance, we inquire about any of the loweſt nervi ſacri near the os coccygis, we muſt not ſtop at the extremity of the os ſacrum, but trace its origin as high as the laſt vertebra of the back, or firſt of the loins.

The membrana arachnoides accompanies the original faſciculi ſeparately, to their paſſage through the lateral elongations of the dura mater, forming a kind of duplicature,

breaks,

breaks, or diſcontinuations, between the cords which run in the vagina of the dura mater. The pia mater adheres very cloſely both to the faſciculi and filaments of which they are compoſed.

Among the original productions of the nerves of the medulla ſpinalis, we ought ſtill to reckon the formation of the nervi acceſſorii of the eighth pair. They ariſe from the lateral parts of this medulla by ſeveral filaments, about the third or fourth vertebrae of the neck, and ſometimes lower. They run up on each ſide between the anterior and poſterior ranks of the nervous faſciculi, gradually increaſing in ſize by the acceſſion of new filaments from the poſterior faſciculi.

Having reached above the firſt vertebra of the neck, they have a kind of adheſion or communication with the neighbouring ganglions of the nervi ſub-occipitales, or thoſe of the tenth pair. Above this adheſion they receive two filaments each, from the back ſide of the medulla, and afterwards continue their courſe towards the great occipital foramen. As they enter the cranium, they communicate with the nerves of the ninth and tenth pairs; and afterwards they join thoſe of the eighth pair, with which they return out of the cranium.

§ 8. *Blood Veſſels of the Brain and Medulla Spinalis.*

Arteries. The arteries which ſupply the cerebrum, cerebellum, and medulla oblongata, come partly from the carotids which enter the cranium through the canals in the apophyſes petroſae of the oſſa temporum, and partly from the vertebrales which enter by the great occipital foramen, and ſend off the arteriae ſpinales into the canal of the ſpine for the medulla lodged there.

All theſe arteries are divided into ſeveral branches, which ſend out a great number of ramifications diſtributed through both ſubſtances of the brain, and through the whole extent of the

the pia mater. The dura mater, both of the cerebrum and cerebellum, has arteries peculiar to itſelf, which have been already deſcribed.

The internal carotid on each ſide enters the cranium by the great canalis petroſus, in an angular or winding courſe, as was obſerved in the deſcription of the ſkeleton. The inner ſurface of this canal is lined by a production common to the dura mater and inferior pericranium, to which the artery adheres only by a looſe filamentary ſubſtance, wherein the plexiform filaments, belonging to the great ſympathetic nerve, run.

Having paſſed through the bony canal, it immediately bends upward toward a notch in the ſphenoidal bone, and through that notch it enters the cranium. Immediately after this it penetrates the cavernous ſinus on the ſide of the ſella turcica; where having formed a third curvature, it goes out from it, from below upwards, and is bent a fourth time round the anterior clinoid apophyſis, from before backward. By this courſe, it is in a manner bathed in the blood of the cavernous ſinus, together with the ſixth pair of nerves.

After this fourth curvature, the internal carotid having now reached the ſide of the infundibulum, and conſequently being very near its fellow, theſe two arteries communicate ſometimes by a very ſhort tranſverſe arterial production. At this place, each of them, after ſending a branch through the foramen opticum to the eye, divides into two principal branches, one anterior, the other poſterior; and ſometimes into three; in which caſe there is a middle branch between the two former.

The anterior branch runs, firſt of all, forward under the baſis of the cerebrum, ſeparating a little from the ſame branch of the other carotid. They approach each other again under the interſtice between the two olfactory nerves, communicating

ting by a very ſhort anaſtomoſis, and ſending ſmall twigs to that pair of nerves. They afterwards ſeparate, being each divided into two or three rami.

The firſt ramus of the anterior branch goes to the anterior lobe of the cerebrum. The ſecond, which is ſometimes double, is inverted on the corpus calloſum, to which it gives ramifications, as alſo to the falx of the dura mater and middle lobe of the cerebrum. The third, which is ſometimes a diſtinct branch, ſometimes only an additional ramus to the ſecond, goes to the poſterior lobe of the cerebrum. This third ramus is often ſo conſiderable, as to deſerve to be reckoned the middle branch of the three principal ones.

The poſterior branch communicates firſt of all with the vertebral artery of the ſame ſide, and is then divided into ſeveral rami on the ſuperficial circumvolutions of the cerebrum, and between theſe circumvolutions all the way to their bottom. The anterior and middle branches, when there are three, diſtribute the ſame kind of ramifications to the circumvolutions, and to their interſtices.

All theſe different ramifications run on the duplicature of the pia mater, from which they receive a kind of additional coats; and the capillaries being diſtributed upon it in a reticular manner, afterwards penetrate the cortical and medullary ſubſtance; in which laſt they terminate inſenſibly.

The vertebral arteries enter through the great occipital foramen, having firſt pierced on each ſide the elongations of the dura mater at the ſame place where the ſub-occipital nerves, or thoſe of the tenth pair, pierce it as they go out; the arteries in this place lying above the nerves.

At their entry into the cranium, they each ſend ſeveral ramifications to the cauda of the medulla oblongata, and to the corpora olivaria and pyramidalia: Which ramifications are diſtributed on the ſides of the fourth ventricle; produce the plexus choroides; are ſpread on the whole ſurface of the cerebellum;

rebellum; inſinuate themſelves between the ſtrata, always inveſted by the duplicature of the pia mater; and are at length loſt in both ſubſtances of the cerebellum.

The two vertebral arteries afterwards turn toward each other, for the moſt part immediately under the poſterior edge of the great tranſverſe or ſemi-annular protuberance of the medulla oblongata, where they unite and form one common trunk. This trunk paſſes directly from behind forward, under the middle of the great protuberance, and partly in the middle groove of the convex ſurface of that protuberance, at the anterior edge of which it terminates.

In its paſſage through the groove, this trunk ſends off ſeveral ſmall branches on each ſide, which ſurround tranſverſely the lateral portions of the protuberance, and are partly lodged in the ſmall lateral grooves of theſe portions. Theſe lateral branches are afterwards diſtributed to the neighbouring parts of the cerebrum, cerebellum, and medulla oblongata.

This common or middle trunk of the vertebral arteries having reached the edge of the great protuberance, is again divided into ſmall branches; each of which ſoon communicates with the trunk of the internal carotid on the ſame ſide. Inſtead of this bifurcation, each of the two laſt, or more anterior lateral branches, ſometimes ſend a ſmall branch forward, which form anaſtomoſes with the internal carotids.

The principal arteries of the medulla ſpinalis, called commonly *arteriæ ſpinales*, are two in number, one anterior, and one poſterior, lodged in the grooves by which the medulla is divided into lateral portions on both ſides. They ariſe from the vertebral arteries, a little above the great occipital foramen, where theſe arteries each ſend a ſmall ramus downward, as ſoon as they enter the cranium; and having got under the extremity of the medulla oblongata, they ſend off two other branches backward.

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The firſt two branches uniting ſoon after their origin, form the arteria ſpinalis anterior, which runs down within the canal of the vertebrae, along the anterior groove of the medulla. The other two ſmall branches are inverted on the ſides of the medulla oblongata, and from thence running backward, they unite much in the ſame manner with the firſt two, and form the arteria ſpinalis poſterior, which runs down along the poſterior groove or the medulla ſpinalis.

The two ſpinal arteries, in their courſe downward along the medulla, ſend off on each ſide lateral ramifications, by which they frequently communicate with each other, and with the vertebral, intercoſtal, lumbar, and ſacral arteries; ſometimes they ſeem to be ſplit for a little way, and then unite again.

The veins of the cerebrum and cerebellum, &c. may, in general, be conſidered as not only forming the longitudinal ſinus of the dura mater, and the two great lateral ſinuſes, but alſo all the inferior ſinuſes of that membrane; in all which ſinuſes the veins terminate by different trunks, in the manner already ſaid in the deſcription of the great ſuperior ſinus. Their principal ramifications accompany all the cortical circumvolutions of the cerebrum, and directions of the ſtrata of the cerebellum, running always in the duplicature of the pia mater. The veins of the plexus choroides, in general, are of the number of thoſe already mentioned.

The veins of the medulla ſpinalis terminate partly in the ſuperior extremities of the two vertebral veins, partly in the two venal ropes termed *ſinus venoſi*, which run down laterally on the convex ſide of the production of the dura mater, and form, at different diſtances, reciprocal communications, by ſemiannular arches, as by ſo many ſubordinate ſinuſes. The two longitudinl ſinuſes communicate likewiſe in their paſſage with the vertebral veins, in the ſame manner as the neighbouring arteries.

From

From the foregoing hiſtory of the arteries belonging to the brain, it appears that a very great quantity of blood, derived from trunks that are near the heart, is, at every pulſation, ſent to this organ: Dr Haller ſays a ſixth part, Dr Monro a tenth part of the whole circulating maſs. Hence it is probable, that the ſtrongeſt parts of the blood, and ſuch as are moſt retentive of motion, go to the head. Is not this evident from the effects of mercurials exerting themſelves almoſt in the head only? from the ſudden force and action of inebriating ſpirits upon the head? from the ſhort ſtupor which camphor excites? from the heat, redneſs, and ſweat, which happen oftener in the face than other parts of the body? to which add, the more eaſy eruption of volatile and contagious puſtules in the face? Dr Wriſberg, however, obſerves, that all theſe arguments are not of the ſame force; for mercury, applied in different ways to the body, produces its effects not in the head alone; ſince it occaſions in ſome patients a diaphoreſis, in others a diarrhoea, and in others it acts as a diuretic. The well guarded paſſage of the great and important veſſels in their aſcent to the head, defends them from any material injury. The frequent inoſculations of the one trunk, with the other going to the head, as well as the frequent communication of their branches among themſelves, leſſen any danger that might enſue from obſtruction. Hence, when the carotids are tied, the animal neither dies nor ſeems to be very uneaſy. The conſiderable flexures of the vertebral and carotid artery ſerve to moderate the impulſe of the blood coming to the brain, ſince a great part of the velocity which the blood receives from the heart, is ſpent by the various inflections. To which we may add, that the arteries in their aſcent, grow larger and wider.

With reſpect to the brain, we obſerve it providently ſurrounded on all ſides, firſt by a ſphere of bones, conſiſting of many diſtinct portions, which ſuffer it to extend, and at the ſame

ſame time effectually guard it againſt external preſſure. The dura mater lines the internal ſurface of this bony ſphere, and is ſo firmly attached to it by a vaſt number of ſmall veſſels, as to be no where eaſily ſeparable in a healthy perſon; this membrane being very thin and ſmooth, adheres leſs firmly to the bones, and more ſtrongly to the ſutures. In younger ſubjects, the adheſion of the dura mater to the ſkull is ſo great, that the ſeparation of it pulls off the fibres of the bones, to which it is connected. In adults, many of the veſſels being effaced, it becomes more eaſily ſeparable; yet it is not without ſome force that the dura mater can, even in old men, be ſeparated from the ſkull. The bloody drops which appear on the ſurface of the dura mater, after removing the cranium, are occaſioned by the rupture of the veſſels going from the membrane into the ſubſtance of the brain. Hence appears the vanity of all that has been advanced concerning the motion of the dura mater. As to the motion which is remarked by the writers of obſervations upon wounds in this part, it ſeems to be in conſequence of the beating of the arteries, or of the brain ſwelling during expiration. That part, ſays Dr Haller, which is properly the dura mater, viz. the inner portion, has neither nerves nor ſenſation, nor irritability, while the outer part is ſupplied with ſmall nerves and blood-veſſels coming through all the holes of the ſkull Later phyſiologiſts, however, obſerve in general, that the dura mater has few nerves, and only little ſenſibility in the ſound ſtate; but ſurgical phenomena ſhew that it is not totally deſtitute of ſenſibility.

The internal part of the dura mater, leaving the external part adhering firmly to the bones of the ſkull, runs inwards to form the proceſſes, which ſerve to prevent the parts from preſſing one another in all ſituations and poſtures of the body. Theſe proceſſes likewiſe hinder one part of the brain from bruiſing the other by any ſhock or concuſſion. Hence

it is, that in active quadrupeds, where a concuſſion is more likely to happen, the brain and cerebellum are divided by a bony partition.

With reſpect to the glands of Pacchioni placed near the falx, their uſe is not yet ſufficiently known. The vapour, which exhales from the ſurface of the pia mater, is not ſeparated by theſe glands, for it is every where exhaled, even into the ventricles, where there are no glands; but it plentifully tranſpires every where from the mouths of the leaſt arteries; as we ſee by experience, when water or glue are injected, which ſweat out through every point in the ſurface of the pia mater.

The next covering of the brain is the arachnoides, which ſurrounds the whole ſurface of the brain, as the former does the internal cavity of the cranium. This very thin or tender member, being pellucid like water, every way ſurrounds the brain, whoſe inequalities it climbs over; and although it be ſo extremely thin, yet it is tolerably ſtrong, and ſurrounds the larger veſſels, ſo as to make them ſeem to run between the pia mater and arachnoides.

The third or innermoſt covering of the brain, which is ſoft and cellular, is properly the *pia mater*. This immediately inveſts the whole ſurface of the brain and ſpinal marrow on all ſides, is tender, and conſiſts of a vaſt number of ſmall veſſels which are joined together by cellular matter, and conveyed into the ſubſtance of the brain.

The *veins* of the brain are not diſpoſed in the ſame manner with thoſe in other parts of the body. For they have no valves, nor do they run together in company with the arteries, nor have their trunks the ſtructure which is commonly obſerved in the other veins. The veins from the different parts of the brain run into ſinuſes already deſcribed.

The great quantity of blood which goes to the brain, the greater impulſe with which it is ſent into the carotid arteries,

the

the ſecurity of this part from every kind of preſſure by a ſtrong bony fence, the ſlower motion of the blood through the abdominal viſcera and lower extremities, and the perpetual exerciſe of the brain and ſenſes, all determine a copious flux of blood to theſe parts; ſome other cauſes alſo ſerve to fill the head largely with blood. Hence it is that a redneſs of the face, a turgeſcence, a ſparkling of the eyes, with a pain of the head, a pulſation or throbbing of the arteries, and a bleeding at the noſe, are produced by violent exerciſes or motions of the body. Hence, therefore, it is evident, that if the veins were of a thin ſtructure, and round ſhape in the brain, they would unavoidably be in greater danger of rupturing, (to which, even in their preſent ſtate, they are often liable) and conſequently apoplexies would be much more frequent. To avoid this inconvenience, therefore, nature has given a different figure to the veins carrying the blood from the brain, by which they are more eaſily and largely dilatable, becauſe they make an unequal reſiſtance: Their texture is likewiſe very firm, and more difficultly ruptured, eſpecially in the larger ſinuſes, which perform the office of trunks; but as to the ſinuſes of the leſſer ſort, they are either round, half cylindrical, or of an irregular figure. Beſides this, nature has guarded the ſinuſes by croſs beams, or fraena, internally, made of ſtrong membranes, and detached from the right to the left ſide at the bottom of the ſinus, which, in greater diſtenſions, they draw towards a more acute angle, ſtrengthening and guarding it from a rupture. She has likewiſe furniſhed theſe veins with numerous inoſculations, by which they communicate with one another, with the external veins of the head, and with thoſe of the ſpinal marrow; and by this contrivance, they are capable of evacuating themſelves more eaſily whenever they are overcharged with blood.

Some writers have doubted, Whether a part of the arterial blood is not poured into the ſinuſes of the brain; and whether

whether the ſinuſes have not a pulſation excited from that blood? That they have no pulſation, Dr Haller ſays, is paſt doubt; becauſe the dura mater every where adheres firmly to the ſkull, but much more firmly to thoſe parts which are the ſeats of the ſinuſes. But Dr Monro obſerves, that whilſt the heart is performing its ſyſtole, the arteries here, as elſewhere, may be dilating; and, in the mean time, a quantity of blood, equal to that which is dilating them, is paſſing out of the head by the veins. *See* Obſ. on the Nervous Syſtem. Indeed the ſinuſes receive liquors injected by the arteries; but whether they tranſude through the ſmall exhaling arterial veſſels, or whether they firſt make a complete circle through the veins, as indeed is much more probable, we are not yet furniſhed with experiments enough to determine.

All the blood of the brain is finally conveyed into the jugular veins, which are very dilatable, and are for that reaſon guarded with valves to prevent a return of the venous blood from the right auricle, being at the ſame time ſurrounded with much cellular ſubſtance. As to the blood which goes from the head to the vertebral veins, it is a very inconſiderable quantity; but the jugulars anſwer in ſuch a manner to the great upper vena cava, that they afford the beſt and eaſieſt paſſage for the blood to return to the heart in a direct courſe. The branches of theſe, *i. e.* jugular veins, are nearly the ſame with the branches of the arteries, namely, one going to the brain, and another to the face.

The veins form innumerable anaſtomoſes with one another, that the blood may return with the greateſt eaſe from the head, the repletion of which is very dangerous. The brain is alſo more eaſily evacuated in the time of inſpiration, for it then ſubſides, as we ſee when the ſkull is opened, but ſwells during the time of expiration. Hence, blowing the noſe, ſneezing, and coughing, are dangerous to thoſe whoſe brain is ſwelled by retained blood.

Whether

Whether lymphatic veſſels are to be ſeen in the brain, is queſtioned by ſome writers. Dr Haller thought it probable that no lymphatic veſſels are in the brain, becauſe no conglobate glands are found there; and that the ſuperfluous moiſture is abſorbed by the red veins. But, according to moſt of the preſent phyſiologiſts, lymphatic veſſels take up the ſuperfluous fluids of the brain, as well as of the other parts of the body, although they cannot be diſtinctly ſhewn

"Scarcely in any viſcus," ſays Dr Wriſberg, "has the exiſtence of lymphatic veſſels been oftener aſſerted, and again denied, than in the brain. Although, indeed, I am fully certain, that a group of lymphatic glands is nowhere found without lymphatic veſſels, I could not, however, aſſert that, where glands do not appear, lymphatic veſſels are wanting. By analogy drawn from the whole body, and all the viſcera, I am led to think that the brain is not deſtitute of its aqueous veſſels, and that they run in particular upon the ſurface, not in the middle of its ſubſtance, although I myſelf have never ſeen any other than thoſe going on the choroid plexus towards the tentorium, and on the inner ſurface of the dura mater, in the courſe of the ſuperior longitudinal ſinus The induſtrious and celebrated Sommering confirms the obſervations of King, Collins, and Pacchioni, who ſaw lymphatics upon the pia mater. I would aſk, May they be joined with the glands of Pacchioni? May theſe corpuſcles ſupply the place of lymphatic glands?"

It now remains for us to ſpeak of the encephalon itſelf. Upon the ſurface of the brain lies the cortex, the fabric of which has been a long time controverted; but it is now ſufficiently evident, from anatomical injections, that the greater part of it conſiſts of mere veſſels, which are every way inſerted from the ſmall branches of the pia mater, detached like little roots into the cortical ſubſtance. Theſe veſſels, in their natural ſtate, convey a juice much thinner than blood; although,

though, in ſome diſeaſes, and by ſtrangling, they often, eſpecially in brutes and birds, receive even the red parts of the blood. The remaining part of the cortex, which is not filled by any injection, is probably either an aſſemblage of veins, or of yet more tender veſſels; for no diſſimilar parts are apparent in the cortex, whilſt it is in an entire or natural ſtate; and hence we are not permitted to conclude that part of it is tubular, and part ſolid. As to glandules making the fabric of the brain, that notion has been diſcarded by univerſal conſent, as not being founded on the leaſt probability.

In order to gain a knowledge of the nature of the medulla, which lies under the cortex, we are to conſider the anatomical ſtructure of this part of the human brain, compared with the brains of brute animals and fiſh. This part of the brain, therefore, which lies immediately under the outer gyri or convolutions of the cortex, is of a white colour, and becomes gradually broader, and more abundant; ſo that, at length, it makes up the whole oval ſection of the brain, except only the gyri in the circumference.

The nerves of the brain, as well as of the ſpinal marrow, divide into branches like the blood-veſſels, but in acute angles, and often in a courſe manifeſtly retrograde, they generally, but not always, gradually become ſofter, and leſs bulky, as they recede from the brain, till at length their ultimate extremities, which are ſeldom viſible, ſeem to terminate in a pulp, by depoſiting the firm integuments with which they were covered, as we obſerve in the optic nerve. The rectilineal courſe of the fibres, continued from the brain itſelf, is never broken off by the diviſion or ſplitting of a nerve into ſmaller threads; but the fibres themſelves recede from each other by an opening of the cellular ſubſtance that tied them together. This appears from the diſorders which are determined not to all, but only to ſome ſingle parts of the body,

body, by injuries of the brain; as a loſs of the voice, deafneſs, dumbneſs, and palſies of particular muſcles. The nerves are connected in their courſe by the cellular ſubſtance to the adjacent parts, but have hardly any elaſticity; whence they do not fly back after being cut, but only expel, by the contraction of their integuments, the ſoft medulla which they include. Though they be ever ſo much irritated, they are neither contracted, nor rendered ſhorter during the muſcular motion which they produce. A great many nerves, ſays Haller, are ſent into the muſcles; many of them go to the ſkin; fewer to the viſcera, and very few to the lungs. Wriſberg, however, obſerves, that more nerves manifeſtly enter the organs of ſenſe than the muſcles; and that the lungs are ſupplied with more nerves than the ſpleen, uterus, and other viſcera. Haller alſo aſſerts, that no nerves go to the dura and pia mater, arachnoides, tendons, capſules, and ligaments. That theſe parts have few nerves is certain; but that nerves can be traced into ſome of them, eſpecially into ligaments, cannot now be denied.—See Monro and Walter's Tables. They make frequent inoſculations with each other; or one trunk gives off many branches, and from the conjunction of theſe branches, the nervous ganglia are principally formed; *i. e.* hard nervous tumours, for the moſt part repleniſhed with blood-veſſels, and included in a firm membrane. Theſe Dr Monro conſiders as ſources of nervous matter and energy; for they are full of nervous fibrillae, intermixed with a yellowiſh or reddiſh brown ſubſtance, ſomething ſimilar to the cortical ſubſtance of the brain.—See Obſervations on the Nervous Syſtem.

Thus much we are taught by anatomy concerning the brain and nerves; it now remains that we explain the phyſiological uſes of theſe parts. Every nerve that is irritated by any cauſe produces a ſharp ſenſe of pain. To feel or perceive is to have the mind changed or affected by a change or affection

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of the body. It is the medullary part of the nerve which feels. If the nerve was endowed with any peculiar ſenſe, that ſenſe periſhes when the nerve is compreſſed or cut thro'; the ſenſes of the whole body are loſt by a compreſſion of the brain, and a preſſure of the ſpinal marrow deprives only thoſe parts which are below it of ſenſation. If a preſſure be made on the brain where particular nerves ariſe, then only thoſe ſenſes depending on theſe nerves are loſt. Thoſe parts of the body that are furniſhed with nerves, are the only parts endued with ſenſation, which is greater in proportion to the quantity of nerves ſent to the parts, of which we have examples in the eye and the penis; thoſe have leſs ſenſibility which receive few nerves, as the viſcera; and thoſe which have feweſt nerves, as the dura mater, tendons, ligaments, ſecundines, bones, and cartilages, have little or no ſenſation in the ſound ſtate.

It is therefore evident, that all ſenſation ariſes from the impreſſion of an active ſubſtance on ſome nerve of the human body; and that the ſame is then repreſented to the mind by means of that nerve's connection with the brain. It ſeems to be falſe, that the mind perceives immediately by means of the ſenſoria and branches of the nerves. For this opinion is refuted by the pains felt after amputation, by the ceſſation of all pain when the nerve is compreſſed, and by defects or faults of the ſenſes in conſequence of diſeaſes of the brain. And that the effect of the ſenſes is preſerved in the brain, is evident from the loſs of memory which follows an injury or compreſſion of the brain; and alſo from the delirium which happens in ſome diſeaſes, and the ſtupor and ſleepineſs which happen in others.

Another office of the nerves is to excite motions, even the moſt violent, in the muſcles. When a nerve is irritated, every muſcle to which it goes is immediately convulſed; or, if it ſends branches to ſeveral muſcles, they are all convulſed at the

the ſame time. This happens both during the life of the animal, and a little after its death, while all the parts remain moiſt. By a great irritation other muſcles, beſides thoſe to which it ſends branches, are thrown into convulſions, and afterwards the whole body. Nor is it neceſſary that the nerve ſhould be whole; for even when it is cut, an irritation of it will excite ſimilar motions in the muſcles. On the other hand, when a nerve is compreſſed or tied, a palſy follows; that is, the muſcles which have their nerves from it lie unmoved, when they are commanded by the will to act; but they recover their motion when the compreſſion is removed, provided the nerve has received no hurt.

But the medulla of the brain being vellicated, or irritated deeply in its crura, dreadful convulſions enſue throughout the whole body; and this effect is univerſally produced, what part of the brain ſoever be irritated; whether it be the brain itſelf, the cerebellum, or the corpus calloſum. The ſame conſequences alſo follow, if the ſpinal marrow be irritated. But if the encephalon itſelf be compreſſed in any part whatever, there follows thence a loſs of ſenſe and motion in that part of the body whoſe nerves come from the affected or compreſſed quarter of the brain. This fact is proved by experiments made in diſeaſes of the brain, where the origin of particular nerves have been compreſſed; thus the voice, the power of deglutition, the motion of an arm or a leg are loſt, if the origin of the nerves, on which theſe faculties and motions depend, be compreſſed. This is ſtill more evident in irritations or compreſſions of the ſpinal marrow, which produce reſpectively convulſions or palſies of thoſe parts that receive nerves from or below the place injured. If any large portion of the brain be compreſſed by an extravaſation of blood, by a collection of water, by a ſcirrhus, or by an impacted bone, or by any mechanical cauſe whatever, then, in proportion to the violence of the compreſſion, there will

follow either a partial or a total loſs of the power of motion, theſe organs obedient to the will being affected in conſequence of a ſlighter compreſſion ; but all the organs, if the preſſure be great. The effects above recited ceaſe when the cauſe is removed. It may be proper to add, that if the ſpinal marrow be hurt in the neck, death immediately follows, probably becauſe the nerves of the heart chiefly ariſe from that part.

From theſe conſiderations, we cannot doubt that the cauſe of all motion in the human body ariſes from the brain, and its annexed cerebellum and ſpinal marrow ; and that it thence proceeds through the nerves to all the muſcular parts of the body. Beſides, the cauſe of this motion cannot reſide in the parts themſelves, becauſe otherwiſe the moving cauſe would continue to act after being ſeparated from the brain ; nor would it be increaſed by irritating the brain, or weakened by a compreſſure of it.

Is there in the brain any principal part, in which the origin of all motion, and the end of all the ſenſations reſide, and where the ſoul has its ſeat ? Is this opinion proved by the frequent obſervation, that the ſenſes are ſometimes entire, and that motion likewiſe remains, though the brain be materially injured ? Is the ſeat of the ſoul in the corpus calloſum ? Is this opinion ſhewn by the greater fatality of wounds or diſeaſes in the corpus calloſum ? Is this body ſufficiently connected with the nerves ? Are there any experiments which prove that from thence the fifth, ſeventh, and other nerves ariſe ? Doth not the ſame, or even greater mortality of wounds in the medulla ſpinalis prove the ſame thing ? Yet this is not the ſeat of the ſoul, ſince though it is compreſſed, or even deſtroyed, the perſon will ſurvive a long time with the perfect uſe of all his mental faculties. Laſtly, this opinion is oppoſed by numerous facts : Birds have no corpus calloſum, and wounds in that body are not more mortal than

than thoſe in other parts of the brain, as appears from undoubted experiments.

The prerogative of exciting vital motions, is not more peculiar to the cerebellum than to the other parts of the encephalon; nor does it ſufficiently appear, that the vital and animal functions are diſtinct: For the cerebellum does not produce the nerves of the heart and of the other vital organs, and the brain thoſe which go to the organs of ſenſe and voluntary motion. From the cerebellum the fifth nerve is moſt evidently produced; but that goes to the tongue, pterygoid, buccinator, temporal and frontal muſcles, to the ear, the eye, the noſtrils; parts which are either moved by the will, or deſtined for ſenſe. Again, the ſame nerve, like the eighth, ſends vital branches to the heart and lungs, animal and voluntary ones to the larynx, and ſenſitive ones to the ſtomach. Again, it is not even true that diſorders of the cerebellum bring on ſo certain and ſpeedy death as is generally imagined; for ſome experiments, even of our own making, ſhew that it has born wounds and ſcirrhi, without taking away life. Laſtly, it is not much different from the brain, only that it is ſofter and more tender; and we have often known wounds of the cerebellum cured. The power, however, of this part, in exciting convulſions, is ſomewhat greater than that of the brain.

We muſt inquire experimentally concerning the ſeat of the ſoul. In the firſt place it muſt be in the head, and not in the ſpinal marrow: For though this is obſtructed, the conſtancy of the mind remains the ſame. Again, from the experiment of convulſions ariſing, when the inmoſt parts of the brain are irritated, it appears to be ſeated, not in the cortex, but in the medulla; and, by a probable conjecture, in the crura of the medulla, the corpora ſtriata, thalami, pons, medulla oblongata, and cerebellum. And again, by another not abſurd conjecture, it is perhaps ſeated at the origin of every

every nerve, as the firſt origin of all the nerves taken together make up the cenſorium commune. Are the ſenſations of the mind repreſented there, or do the voluntary and neceſſary motions ariſe in that place? This ſeems very probable; for it is ſcarcely poſſible, that the origin of motion can lie below that of the nerve, ſince the nerve is ſimilar throughout its whole length. The origin of motion cannot be in the arteries, which have neither the faculty of ſenſation nor that of voluntary motion. It therefore follows, that the ſeat of the ſoul muſt be where the nerve firſt begins its formation or origin.

We come now to explain the manner in which the nerves become the organs of ſenſe or motion, which, lying hid in the ultimate elementary fabric of the medullary fibres, ſeem to be placed above the reach both of ſenſe and reaſon. We ſhall nevertheleſs endeavour to make this as plain as experiments will enable us. And firſt, it is demonſtrated, that the ſenſation does not come through the membranes from the ſentient organ to the brain, nor that motion is ſent through the coverings from the brain into the muſcle; for the brain itſelf lies deeper than theſe membranes, and receives the impreſſions of ſenſe, and, when hurt, throws the muſcles into convulſions. Moreover it is certain, that the nerves ariſe from the medulla of the brain; for by ocular inſpection we ſee that to be the caſe in all the nerves of the brain, more eſpecially in the olfactory, optic, fourth, and ſeventh pair of nerves, which continue their medullary fabric a long way before they put on the covering of the pia mater.

We muſt therefore next inquire what this medulla is. It is a very ſoft ſubſtance; its compoſition is fibrous, as appears from innumerable arguments: Its fibres are viſible in the corpus calloſum, in the ſtriatum, in the thalami of the optic nerves, and ſpinal marrow; and ſtill more evidently in the brains

brains of fiſh, and eſpecially in their thalami optici; but in no part of the human brain does the fibrous nature of the medulla more evidently appear than in the fornix, eſpecially when immerſed in ſome of the acids. Again, that the fibres of the brain are continuous with thoſe of the nerves, ſo as to form one extended and open continuation, appears very evidently in the ſeventh, fourth, and fifth pair of nerves. There is a great deal of oil in the medulla, upwards of a tenth part of its whole weight.

But here a controverſy begins concerning the nature of theſe fibres, a congeries of which compoſes the ſubſtance of the medulla and of the nerves. That this is a mere ſolid thread, and only watered by a vapour exhaling into the cellular fabric which ſurrounds the nervous fibres, has been aſſerted by many of the moderns; but that, when it is ſtruck by a ſenſible body, a vibration is excited, which is then conveyed to the brain.

But the phenomena of wounded nerves will not allow us to imagine the nervous fibres to be ſolid; for, if irritation cauſes a nerve to ſhake, (in a manner ſomewhat ſimilar to an elaſtic cord, which trembles when it is taken hold of) the nerve ought to be made of hard fibres, and tied by their extremities to hard bodies: They ought alſo to be tenſe; for neither ſoft cords, nor ſuch as are not tenſe, or ſuch as are not well faſtened, are ever obſerved to tremulate. But all the nerves at their origin, are medullary, and very ſoft, and exceedingly far from any kind of tenſion. Where they paſs through channels, and are well guarded, they retain the ſame ſoft texture, and are not covered with membranes; as the intercoſtal nerves, and the ſecond nerves of the fifth pair. Some alſo are ſoft throughout their whole length, whatever their ſize be. For example, the ſoft olfactory and acouſtic nerves, from which laſt we would moſt readily expect a tremor produced by ſound. Again, though the nerves

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are hard; they are ſoftened in the viſcera, muſcles, and ſenſoria, before they exert their operations. The nervous fibres, being neither firmly fixed at each end, nor tenſe, cannot therefore tremulate like a tight ſtretched cord. Another argument againſt their tremulation is, that, through their whole length, the nerves are firmly attached to the ſolid parts by the cellular fabric. An example of this fact is ſeen in thoſe very material nerves, the nerves of the heart, which are tied to the great arteries and pericardium. Finally, that the nerves are deſtitute of all elaſticity, is demonſtrated by experiments, in which the nerves cut acroſs neither ſhorten, nor draw back their divided ends to the ſolid parts; but are rather more elongated by their laxity, and expel their medulla in form of a protuberance. Again, the extreme ſoftneſs of the medulla in the brain, with all the phenomena of pain and convulſion, leave no room to ſuſpect any ſort of tenſion concerned in the effects or operations produced by the nerves.

Add to this, that the force of an irritated nerve is never propagated upward, ſo as to convulſe the muſcles that are ſeated above the place of irritation. This is a conſequence altogether diſagreeing with elaſticity; for an elaſtic cord propagates its tremors every way, from the point of percuſſion to both extremities. But, if neither phenomena or ſenſe nor motion can be explained from the nature of elaſticity, the only probable ſuppoſition that remains is, that there is a liquor ſent from the brain, which, deſcending through the nerves, flows out at their extremities; the motion of which liquor, quickened by irritation, operates only according to the direction in which it flows through the nerve; ſo that convulſions cannot thereby aſcend upwards, becauſe of the reſiſtance made by the freſh afflux of the fluid from the brain. But the ſame liquid being put in motion in an organ of ſenſe, can carry that ſenſation upwards to the brain; ſince

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it is reſiſted by no ſenſitive torrent coming from the brain in a contrary direction.

It is therefore probable, that the nervous fibres, and thoſe of the medulla of the brain, which are of the ſame nature, are hollow. The objections againſt this doctrine are ſo few, and at the ſame time ſo frivolous, that they need not be mentioned. If they are tubes, it is very probable that they have their humours from the arteries of the brain.

There are many doubts concerning the nature of this nervous liquid. Several of the moderns will have it to be extremely elaſtic, of an etherial or of an electrical nature; the ancients ſuppoſed it to be incompreſſible and watery, but of a lymphatic or albuminous nature. Indeed, it is not to be denied that we have many arguments againſt admitting either of theſe opinions. An electrical matter is doubtleſs very powerful, and fit for motion; but then it is not confineable within the nerves, ſince it penetrates throughout the whole animal to which it is communicated, exerting its force upon the fleſh and fat, as well as upon the nerves. In a living animal, the nerves only, or ſuch parts as have nerves running through them, are affected by irritation; and therefore this liquid muſt be of a nature that will make it flow through, and be contained within, the narrow tubes of the nerves. And a ligature on the nerve takes away ſenſe and motion, but cannot ſtop the motion of a torrent of electrical matter.

A watery and albuminous matter is common to moſt of the juices in the human body, and may therefore be readily granted to the juice of the nerves. The nervous fluid may probably be ſimilar to the water exhaled into the ventricles of the brain; and this opinion is ſtrengthened by the flux of a gelatinous or lymphatic juice from the brain of fiſhes, and nerves of large animals, when cut. But, are theſe properties ſufficient to explain the wonderful force of convulſed nerves, obſervable

obſervable in the diſſections of living animals, even of the ſmalleſt inſects? or to account for the great ſtrength of mad and hyſterical people? Is not this difficulty ſomewhat leſſened from the hydroſtatical experiments of attraction in ſmall tubes; which, although it may explain the ſtrength and motion, is nevertheleſs inconſiſtent with the celerity?

The nervous liquor, then, which is the inſtrument of ſenſe and motion, muſt be exceedingly moveable, in order to carry the impreſſions of ſenſe, or the commands of the will, to the places of their deſtination, without any remarkable delay; nor can it receive its motions only from the heart. Moreover, it is very thin and inviſible, and deſtitute of all taſte and ſmell; yet reparable from the aliments. It is carefully to be diſtinguiſhed from that viſible, viſcid liquor, exhaling from the veſſels in the intervals between the nervous cords.

That this liquor moves through tubes rather than through a ſpongy ſolid, we are perſuaded, from its celerity, and from the analogy of all the fluids of the body, fat only excepted, running through their proper veſſels.

On the whole, therefore, it certainly appears, that, by the veſſels of the cortex, ſome kind of fluid is inſtilled into the tubes of the medulla; which fluid is continued through the extremely ſmall tubes of the nerves to their extremities, and is the cauſe both of ſenſe and motion. But there will be a twofold motion in that humour; the one ſlow and conſtant, from the heart; the other not continual, but exceedingly ſwift, which is excited either by ſenſe, or any other cauſe of motion ariſing in the brain.

The ſame nerves muſt evidently preſide over both ſenſe and motion; as we cannot admit a diſtinction between the two ſyſtems of motory and ſenſitive nerves. If ſenſe ſometimes remain after motion is deſtroyed, this ſeems to be becauſe much more ſtrength is required for the latter. Dying people hear and ſee when they are incapable of motion.

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If it be aſked, What becomes of this nervous juice, which cannot but be ſeparated in great abundance, from ſo large a quantity of blood paſſing through the brain very ſwiftly, ſince we ſee very large ſecretions in parts remote from the heart, and through which the blood circulates more ſlowly, as in the ſmall renal and meſenteric arteries? We anſwer, that it probably exhales through the cutaneous nerves. The laſſitude, both with reſpect to ſenſe and motion, which may be overcome by ſpiritous medicines, ſhews that this liquid may be both loſt and repaired. Many anatomiſts have thought that it alſo exhales into the various cavities of the body, as that of the ſtomach and inteſtines. We may expect ſome part of it to be reſorbed, that the nobleſt humour of the body may not be too quickly diſſipated. That it nouriſhes the body is incredible; for it is too moveable to adhere; and, beſides, this property of adhering belongs only to ſlow moving and viſcid humours.

What is the deſign of ſo many protuberances in the brain? What are the particular uſes of the ventricles, nates, and teſtes; the diſtinction of the brain from the cerebellum; and the communication betwixt one ſide of the brain, cerebellum, and ſpinal medulla, with their oppoſite ſides, by ſo many tranſverſe bundles of fibres? Future experience alone can determine theſe circumſtances, when the brains of ſeveral animals ſhall have been compared with their functions.

The ventricles ſeem to be uſeful in preſerving a neceſſary diſtinction of the parts, and in ſeparating them from each other. That the corpora ſtriata or thalami might keep their medullary parts from cohering one to another, it was neceſſary for a vapour to be poured between them; and the ſame is true with regard to the parts of the brain and cerebellum. Beſides the conjectures propoſed by authors, Dr Monro adds, That the ventricles ſerve to increaſe the ſurface of the pia

mater; and that, whatever purpoſes are ſerved by that membrane, and its veſſels, on the ſurface of the brain, we muſt ſuppoſe the ſame performed by it within the ventricles. Perhaps, likewiſe, the neceſſity of adminiſtering a degree of warmth to the cloſe medulla of the brain may be one of the uſes of theſe cavities; eſpecially as the arteries, by their means, are diſtributed in greater numbers. Perhaps, alſo, it was proper, that, in the inmoſt part of the brain, ſmall veſſels only, without any large ones, ſhould enter. We may likewiſe ſuſpect, that the ſoftneſs of the fibres of the brain requires ſhortneſs in order to ſuſtain their own weight.

The uſes of moſt of the protuberances are as yet unknown, and muſt be learned from anatomical experiments made on animals the likeſt to man. Experiments on parts ſo ſmall, and ſo deeply ſeated as to be inacceſſible in living animals, ſeem to afford little hopes of ſucceſs. Are theſe parts the diſtinct provinces which our different ideas inhabit? Do the thalami ſeem to be an inſtance of this ſuppoſition? In conſidering this ſubject, it will be neceſſary to remember that moſt of theſe protuberances ſend out no nerves at all.

The ſtriae or internal ducts ſeem to afford ſome kind of communication between the motions, and perhaps between the ſenſes. Some of theſe ducts join the brain with the cerebellum; others join the ſpinal marrow with the nerves of the brain itſelf, as the acceſſory nerve; and moſt of them join the right and left parts together, as the anterior and the two poſterior commiſſures of the corpus calloſum, and the ſtriae between the proceſſes of the cerebellum and teſtes; to which add the medullary croſs-bars in the medulla oblongata and ſpinalis. This ſtructure explains, in a very ſatisfactory manner, the obſervation, that, when the right ſide of the brain is injured, all the nerves which, on the contrary, belong to the left ſide of the body, become diſeaſed or paralytic, and the reverſe. Moreover, by this contrivance, nature

ſeems

ſeems to have provided, that, in whatever part of the brain any injury may happen, the nerve thence ariſing is not always deprived of its uſe. For, if the nerve receives its fibres by communicating bundles, as well from the oppoſite as from its own hemiſphere of the brain, its office may in ſome meaſure be continued entire by the fibres which it receives from the oppoſite ſide, even after thoſe of its own ſide are deſtroyed. Accordingly, we have numerous inſtances of wounds, and with a conſiderable loſs of ſubſtance from the brain, which have not been followed with injury to any nerve, or to any of the mental faculties. Many other leſs inequalities, ſtripes, protuberances, and nerve-like impreſſions, appear in the brain from mechanical neceſſity, the pulſation of the veſſels, and the preſſure or figure of the continuous incumbent parts.

Sect. II. The Eye.

§ 1. *The Eye in General.*

Situation and Compoſition. The eyes are commonly two in number, ſituated at the lower part of the forehead, one at each ſide of the root of the noſe; and they conſiſt of hard and ſoft parts. The hard parts are the bones of the cranium and face, which form two pyramidal or conical cavities, like funnels, to which we give the name of *orbits*. The ſoft parts are of ſeveral kinds.

The principal and moſt eſſential ſoft part in each organ is the globe or ball of the eye; the others are partly external and partly internal. The external parts are the ſupercilia or eye-brows, the palpebrae or eye-lids, the caruncula lachrymalis, and the puncta lachrymalia: and the internal parts

parts are the muſcles, fat, lachrymal gland, nerves, and blood-veſſels.

The orbits. Seven bones are concerned in the compoſition of each orbit, viz. the os frontis, os ſphenoidale, os ethmoides, os maxillare, os malae, os unguis, and os palati. In each orbit we are to conſider the edge, ſides, and bottom. The edge is formed by the os frontis, os maxillare, and os malae; the bottom by the os ſphenoides and os palati; and all theſe bones, except the os palati, contribute to form the ſides. The bottom is perforated by the foramen opticum of the os ſphenoides; and the external ſide near this foramen by two orbitary fiſſures; one ſuperior, called *ſphenoidalis*, the other inferior, called *ſpheno-maxillaris*, already mentioned in the deſcription of the ſkeleton.

All the cavity of the orbit is lined by a membrane, which is an elongation or production of the dura mater; and it comes partly through the foramen opticum of the os ſphenoides, and partly through the ſphenoidal or ſuperior orbitary fiſſure. This membrane, which may be looked upon as the perioſteum of the orbit, communicates with the perioſteum of the baſis cranii, by the inferior orbitary fiſſure, and with the perioſteum of the face at the edge of the orbit. At the upper part of the edge of the orbits, the two perioſtea form a kind of broad ligament, and a narrow one at the lower part of this edge, which may be called *ligaments of the palpebrae*.

The particular ſituation of the orbits repreſents nearly two funnels, placed laterally at a ſmall diſtance from each other, in ſuch a manner as that their apices are almoſt joined, their neareſt ſides being almoſt parallel, and the other ſides turned obliquely backward; and, for this reaſon, the middle of the great circumference, or edge of each orbit, is at a much greater diſtance from the ſeptum narium than the bottom or apex; and the edge or great circumference is very oblique,

the

the temporal or external angle of the orbit lying more backward than the nasal or internal angle.

§ 2. *The Globe or Ball of the Eye.*

Compoſition. THE globe of the eye, being the moſt eſſential of all the ſoft parts belonging to the organ of ſight, and being likewiſe a part which we are obliged to mention as often as we ſpeak of the other ſoft parts, muſt be firſt deſcribed. It conſiſts of ſeveral proper parts; ſome of which, being more or leſs ſolid, repreſent a kind of ſhell formed by the union of ſeveral membranous ſtrata, called the *coats of the globe of the eye*; and the other parts being more or leſs fluid, and contained in particular membranous capſulae, or in the interſtices between the coats, are termed *the humours of the globe of the eye*. Theſe capſules are likewiſe termed *coats*.

The coats of the globe of the eye are of three kinds. Some of them form chiefly the ſhell of the globe; others are additional, being fixed only to a part of the globe; and others are capſular, which contain the humours. The coats which form the globe of the eye are, the *ſclerotica* or *cornea*, the *choroides*, and the *retina*. The additional coats are two; one called *tendinoſa* or *albuginea*, which forms the white of the eye; and the other, *conjunctiva*. The capſular tunicae are likewiſe two, the vitrea and the cryſtallina.

The globe of the eye, thus formed, receives from behind a large pedicle, which is the continuation of the optic nerve. It is ſituated about the middle of the orbit, in the manner which we ſhall afterwards ſee; and is tied to it by the optic nerve, by ſix muſcles, by the tunica conjunctiva, and by the palpebrae. The back part of the globe, the optic nerve, and muſcles, are ſurrounded by a ſoft fatty ſubſtance, which fills the reſt of the bottom of the orbit.

The

The humours are three; the aqueous, vitreous, and cryſtalline. The firſt may properly enough be called an *humour*, and is contained in a ſpace formed in the interſtices of the anterior portion of the coats. The ſecond or vitreous humour is contained in a particular membranous capſula, and fills above three-fourths of the ſheil or cavity of the globe of the eye. It has been named *vitreous*, from its ſuppoſed reſemblance to melted glaſs; but it is really more like the white of a new-laid egg.

The cryſtalline humour is ſo called from its reſemblance to cryſtal, and is often named ſimply the *cryſtalline*. It is rather a gummy maſs than an humour, of a lenticular form, more convex on the back than on the foreſide, and contained in a fine membrane called *membrana* or *capſula cryſtallina*. What has been here ſaid is ſufficient to give a general idea of the three humours of the globe of the eye.

§ 3. *The Coats of the Eye in particular.*

THE moſt external, the thickeſt, and ſtrongeſt coat of the eye, is the ſclerotica or cornea, and it inveſts all the other parts of which the globe is compoſed. It is divided into two portions, one called *cornea opaca*, or *ſclerotica*, the other *cornea lucida*, which is only a ſmall ſegment of the ſphere ſituated anteriorly.

The ſclerotica is of a white colour, and conſiſts of many fibres cloſely connected; and is of a firm texture, reſembling parchment. About the middle of its poſterior convex portion, where it ſuſtains the optic nerve, it is perforated, and thicker than any where elſe; its thickneſs diminiſhing gradually toward the oppoſite ſide; and its ſubſtance is penetrated obliquely in ſeveral places by ſmall blood-veſſels and nerves. The courſe of the nervous filaments through this coat is very ſingular; they enter the convex ſide at ſome diſtance

diſtance from the optic nerve; and running thence obliquely through its ſubſtance, they pierce the concave ſide near the cornea lucida.

The *cornea lucida*, called alſo ſimply the *cornea*, conſiſts of ſeveral ſtrata or laminae cloſely united by cellular ſubſtance, and of a different texture from the former; beſides, it receives no blood-veſſels in the natural ſtate. When macerated in cold water it ſwells, and then its ſtrata may be ſeparated from each other. If it be macerated till it begin to become putrid, and is then plunged into boiling water, it readily ſeparates from the ſclerotic, being joined only by cellular ſubſtance, (See Traité Complet. d'Anatomie). It is likewiſe thicker than the ſclerotic, eſpecially in new-born children, where its poſterior ſurface almoſt touches the iris.

This portion is ſomething more convex than the ſclerotica, ſo that it repreſents the ſegment of a ſmall ſphere added to the ſegment of a greater; but this difference is not equally great in all perſons. The circumference of the convex ſide is not circular as that of the concave ſide, but tranſverſely oval: For the ſuperior and inferior portions of the circumference terminate obliquely; but this obliquity is more apparent in oxen and ſheep than in man.

The cornea is perforated by a great number of imperceptible pores, through which a very fine fluid is continually diſcharged, which ſoon afterwards evaporates; but we diſcover it evidently by preſſing the eye ſoon after death, having firſt wiped it very clean; for we then ſee a gradual collection of a very ſubtle liquor, which forms itſelf into little drops; and this experiment may be ſeveral times repeated on the ſame ſubject. It is this dew that forms a kind of pellicle on the eyes of dying perſons, which ſometimes cracks ſoon after, as is obſerved in the Memoires of the Academy for 1721.

Tunica

Tunica choroides. The next coat of the globe of the eye is the choroides, which is of a blackiſh colour, more or leſs inclined to red, and adheres, by means of a great number of ſmall veſſels to the ſclerotica, from the inſertion of the optic nerve all the way to the cornea, where it leaves the circumference of the globe, and turns inward, to form a number of little proceſſes termed *ciliary*, which are ſituated at the edge of the cryſtalline lens.

The external lamina of the choroides is ſtronger than the internal, and is of a browniſh colour. At a very ſmall diſtance from the cornea this lamina is moſt cloſely united to the ſclerotica, by means of a whitiſh ring called *ciliary ligament* or *ciliary circle*; and near the edge of the ſclerotica this ring is ſtronger, and of a different texture from what it is any where elſe. The choroides adheres ſo cloſely to the ſclerotica, that if we blow through a ſmall hole made in it, without touching the choroides, the air will penetrate every where between the two coats, but cannot deſtroy this adheſion, or paſs to the cornea. On the inner ſurface of this lamina we diſcover a great number of flat lines in a vortical diſpoſition, which are the veſſels named by Steno *vaſa vorticoſa*, or *vortices vaſculoſi*; of which hereafter.

The internal lamina of the choroides is thinner, and of a darker colour than the external; it is formed of a black varniſh, which is thicker before than behind, and is wanting at the entrance of the optic nerve. At the fore-part of the eye it lies only between the ciliary proceſſes, leaving them white, and adheres to the vitreous humour, forming there a radiated ring. The origin of this ſubſtance has not as yet been obſerved; but, after a nice anatomical injection, Winſlow has obſerved a great number of vaſcular ſtars on its inner ſurface. In Ruyſch's works it is termed *Membrana Ruyſchiana*.

At

At the anterior edge of the choroides we find the *iris* compoſed of two laminae; the poſterior of which, being of the colour of a grape, was called *uvea* by the ancients. In the middle of the iris there is a hole termed *pupil*: This, in a foetus, is covered with a membrane called *pupillaris*, which generally diſappears about the ſeventh month; or between the ſeventh and ninth month, according to Wriſberg. Between the two laminae of the iris, we find two very thin planes of fibres, which have been ſuppoſed to be muſcular; but this matter is not yet fully aſcertained. The fibres of one plane are orbicular, and lie round the circumference of the pupil; and thoſe of the other are radiated, one extremity of which is fixed to the orbicular plane, the other to the great edge of the iris. The iris has motions of ſuch a nature, that the pupil is contracted at the approach of a ſtrong light, and is dilated upon being expoſed to a weak one. The different colours which appear in the iris, ſeem to be owing to an intermixture of veſſels and nerves. That the iris poſſeſſes red veſſels is evident from injection, and from obſervations on the eye during life. (*See* Monro on the Structure and Phyſiology of Fiſhes.)

The plicae or proceſſus ciliares are ſmall radiated and prominent duplicatures of the anterior edge of the choroid coat; and their circumference anſwers partly to that of the ciliary circle. They are oblong thin plates; their external extremities, or thoſe next the choroides, being very fine and pointed; the internal are broad, prominent, bifurcated, and alternately long and ſhort, making ſlight depreſſions on the fore part of the vitreous humour. In the duplicature of each ciliary fold we find a fine reticular texture of veſſels; and ſome anatomiſts pretend to have ſeen fleſhy fibres in the ſame place, lying in ſmall grooves of the membrana vitrea, as we ſhall ſee hereafter.

The ſpace between the cornea and iris contains the greateſt part of the aqueous humour, and communicates by the pupilla with a very narrow ſpace behind the iris, or between that and the cryſtalline. Theſe two ſpaces have been termed *the two chambers of the aqueous humour*, one anterior, the other poſterior, as we ſhall obſerve in deſcribing this humour in particular.

Retina. The laſt coat proper to the eye is of a very different texture from that of the other two coats. It is white, ſoft, and tender, and, in a manner, medullary, or like a kind of paſte ſpread upon a fine reticular web; it lines the bottom of the eye, and is a continuation of the optic nerve. Some authors, as Zinn, affirm, that it terminates at the ciliary circle; others, as Dr Haller, repreſent the whole or a part of it as extended to the lens, and even as giving a covering to that humour; but Dr Monro obſerves, that it ends ſome way behind the ciliary circle (*See* Obſervations on the Nervous Syſtem.) At the place which anſwers to the inſertion of the optic nerve, we obſerve a ſmall depreſſion, in which lies a ſort of medullary button, terminating in a point; and from this depreſſion blood-veſſels go out, which are ramified on all ſides through the ſubſtance of the retina.

It is commonly ſaid, that the retina is a production or expanſion of the medullary ſubſtance of the optic nerve, the ſclerotica of the dura mater, and the choroides of the pia mater, which accompany this nerve; but this opinion is not altogether agreeable to what we obſerve in examining the optic nerve, and its inſertion in the globe of the eye. If we take a very ſharp inſtrument, and divide this nerve through its whole length, between where it enters the orbit and where it enters the globe, into two equal lateral parts, and then continue this ſection through the middle or center of its inſertion, the following phenomena will appear:

That

That the nerve contracts a little at its insertion into the globe; that its outer covering is a true continuation of the dura mater; that this vagina is very different from the sclerotica, both in thickness and texture, the sclerotica being thicker than the vagina, and of another structure; that the vagina from the pia mater forms, through the whole medullary substance of the nerve, several very fine cellular septa; and that, where it enters the globe of the eye, the pia mater does not directly answer to the choroides, and is divided into many small threads, which go through the bottom of the eye to form the retina.

The insertion of the optic nerve in the globe of the eye is not directly opposite to the pupilla; so that the distance between these two parts is not the same when measured on all the parts of the globe. The greatest distance is on the side next the temples, and the smallest next the nose. Winslow observes an inequality of the same kind in the breadth of the uvea, which, in many subjects, is less near the nose than near the temples; so that the center of the pupilla is not the same with that of the great circumference of the iris; and he has seen the same difference in the breadth of the corona ciliaris.

§ 4. *The Humours of the Eye, and their Capsulae.*

The vitreous humour. The vitreous humour is a clear and very liquid gelatinous fluid, contained in a fine transparent capsula, called *tunica vitrea*, together with which it forms a mass nearly of the consistence of the white of an egg. It fills the greater part of the globe of the eye, that is, almost all that space which answers to the extent of the retina, except a small portion behind the uvea, where it forms a fossula, in which the crystalline lens is lodged. This humour being dexterously taken out of the globe, preserves its consistence

ſiſtence for ſome time in the capſula, and then runs off by little and little, till it quite diſappears.

The tunica vitrea is deſcribed by Winſlow as being compoſed of two laminae very cloſely united, which quite ſurround the maſs of humour; but later authors, as Sabatier &c. find only one, which, after covering the vitreous humour, runs to the edge of the lens, and whether it goes farther is uncertain. The anterior part of this membrane, which extends between the vitreous humour and edge of the lens, is covered with black ſtreaks from the pigmentum nigrum, and by different authors has been called *membranula coronae ciliaris*; by Zinn, *zonula ciliaris*. When a puncture is made through this, and air is blown in, it forms a paſſage which runs round the lens; and has been termed *Canalis Petitianus*, after the diſcoverer *Petit*, who deſcribes it in the Memoirs of the Royal Academy, 1728.

The internal ſurface of the tunica vitrea gives off, through the whole ſubſtance of this humour, a great number of cellular elongations or ſepta diſcovered by Riolin, ſo extremely fine, as to be inviſible in the natural ſtate, the whole maſs appearing then to be uniform, and equally tranſparent, through its whole ſubſtance; but they are diſcovered by putting the whole humour, ſoon after it is taken out of the body, into ſome aceſcent and gently coagulating liquor. Theſe cells muſt communicate with each other; for, by puncturing the membrane, and hanging up the eye for a ſhort time, a conſiderable part of the humour runs out, ſo that the eye becomes lighter.

The radiated fulci of the tunica vitrea, which may be termed *fulci ciliares*, are perfectly black when the coat is taken out of the body. This proceeds from the black ſubſtance with which the laminae or proceſſus ciliares, as well as all the reſt of the choroides, are naturally covered, and which remains in the bottom of the fulci after the laminae have been

been taken out. We obſerve very fine veſſels in this humour, which ſhall be deſcribed afterwards.

The cryſtalline humour. The cryſtalline is a ſmall lenticular body, of a firm conſiſtence, and tranſparent like cryſtal. It is contained in a tranſparent membranous capſula, and lodged in the anterior foſſula of the vitreous humour, as has been already ſaid. It is very improperly called *an humour*, becauſe it may be handled and moulded into different ſhapes by the fingers, and ſometimes almoſt diſſolved by different reiterated compreſſions, eſpecially when taken out of the capſula.

The figure of the cryſtalline is lenticular; but its poſterior ſide is more convex than the anterior, the convexity of both ſides being very rarely equal. Steno obſerved, that the lens was compoſed of concentric lamellae; and this has been confirmed by later authors: And Zinn has diſcovered radiated ſtreaks of a pearl colour, dividing the lens into little triangles. —See Zinn de Oculi, tab. vii. fig. vii.

The colour and conſiſtence of the cryſtalline varies in different ages, as was diſcovered by M. Petit the phyſician. (See Memoirs for 1726). Till the age of 30 it is very tranſparent, and almoſt without any colour. It afterwards becomes yellowiſh, and that yellowiſhneſs gradually increaſes. The conſiſtence varies almoſt in the ſame manner, being of an uniform ſoftneſs till the age of 20, and afterwards growing gradually more ſolid in the middle of the maſs; but in this there are varieties, explained in the Memoirs for 1727. Haller takes notice of a watery liquor ſituated betwixt the cryſtalline lamellae, which in old age turns, of its own accord, to a yellow colour; and Steno and Morgagni deſcribe a little water effuſed betwixt the lens and its capſule.

The cryſtalline capſula or coat is formed by a duplicature of the tunica vitrea, or of a proper capſula to which the tunica vitrea is connected. The anterior portion of the cryſtalline

line capſula is thicker than the poſterior, and in a manner elaſtic; and both its thickneſs and elaſticity may be diſcovered in diſſection, without any other artifice.

The anterior portion ſwells when macerated in water, and then appears to be made up of two pelliculae, united by a fine ſpongy ſubſtance. "I demonſtrated this duplicature (ſays Winſlow) very plainly in the eye of an horſe by the knife alone; and I even carried the ſeparation of the two laminae as far as the vitreous coat. Having made a ſmall hole in the middle of the capſula of an ox's eye, and blown into it through a pipe, ſome part of the air remained between the edge of the cryſtalline maſs and that of the capſula, in form of a tranſparent circle."

The aqueous humour is a very limpid fluid, reſembling a kind of lympha or ſerum, with a very ſmall degree of viſcidity; but, in the foetus, and a ſhort time after birth, it is of a reddiſh colour. (See Petit, Memoirs for 1727). It appears to come from the arteries of the iris. Winſlow and others were of opinion, that it has no particular capſula like the cryſtalline and vitreous humour; but, from obſervations lately made in a memoir preſented to the Royal Academy of Sciences in 1760, it appears that the inner ſide of the cornea and anterior ſurface of the iris are covered with an exceedingly fine membrane, ſuppoſed to come from the choroid: Whether it goes into the poſterior chamber is doubtful. The aqueous humour fills the ſpace between the cornea and iris, that between the iris and the cryſtalline, and the hole of the pupilla. Theſe two ſpaces are called the *chambers of the aqueous humour*, and they are diſtinguiſhed into the anterior and poſterior.

The two chambers are not of the ſame extent. The anterior, which is viſible between the cornea and iris, is the largeſt; the other between the iris and cryſtalline is very narrow, eſpecially near the pupilla, where the iris almoſt touches

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the cryſtalline. This proportion between the two chambers has been ſufficiently proved, contrary to the opinion of many ancient writers, by M. Heiſter, Morgagni, aud ſeveral members of the Royal Academy; but none has treated theſe matters at ſo great length as M. Petit the phyſician, as appears by the printed memoirs of that Society.

§ 5. *The Tunica Albuginea, and Muſcles of the Globe of the Eye.*

The tunica albuginea, called commonly the *white of the eye*, and which appears on all the anterior convex ſide of the globe, from the cornea to the beginning of the poſterior ſide, is formed chiefly by the tendinous expanſion of the four recti muſcles. This expanſion adheres very cloſe to the ſclerotica, and makes it appear very white and ſhining; whereas the reſt of it is of a dull whitiſh colour. It is very thin near the edge of the cornea; in which it ſeems to be loſt, terminating very uniformly.

There are commonly ſix muſcles inſerted in the globe of the human eye; and they are divided, on account of their direction, into four recti and two obliqui. The recti are again divided, from their ſituation, into ſuperior, inferior, internal, and external; and, from their functions, into a levator, depreſſor, adductor, and abductor. The two oblique muſcles are denominated from their ſituation and ſize, one being named *obliquus ſuperior* or *major*, the other *obliquus inferior* or *minor*. The obliquus major is likewiſe called *trochlearis*, becauſe it paſſes through a ſmall cartilaginous ring, as over a trochlea or pulley.

The muſculi recti do not altogether anſwer to that name; for, in their natural ſituation, they do not at all lie in a ſtraight direction, as they are commonly repreſented in an eye taken out of the body. To underſtand this, we ought to have a

juſt

juſt idea of the ſituation of the globe in the orbit, and at the ſame time to remember the obliquity of the orbits, as already explained. The globe is naturally placed in ſuch a manner, as that, during the inaction or equilibrium of all the muſcles, the pupilla is turned directly forward; the inner edge of the orbit is oppoſite to the middle of the inſide of the globe; the outer edge of the orbit, becauſe of its obliquity, is behind the middle of the outſide of the globe; and laſtly, the great circumference of the convexity of the globe, between the pupilla and the optic nerve, runs directly inwards and outwards, upwards and downwards.

In this ſituation, the adductor alone is in a ſtraight direction, the other three being oblique; and the abductor is the longeſt, the adductor the ſhorteſt, and the levator and depreſſor of the ſame middle length between the two former. The abductor is likewiſe bent round the outer convex ſide of the globe; the levator and depreſſor are alſo incurvated, but in a leſs degree; whereas the adductor is almoſt ſtraight. The ſuperior oblique are ſituated ſo as to ſerve as antagoniſts to the former. (*See* Deſcription of the Muſcles, Vol. I.)

Uſes of theſe muſcles. The levator moves the anterior portion of the globe upward, when we lift up the eyes; the depreſſor carries this portion downwards; the adductor towards the noſe, and the abductor towards the temples.

When two neighbouring recti act at the ſame time, they carry the anterior portion of the globe obliquely towards that ſide which anſwers to the diſtance between theſe two muſcles: And when all the four muſcles act ſucceſſively, they turn the globe of the eye round, which is what is called *rolling the eyes.*

It is to be obſerved, that all theſe motions of the globe of the eye are made round its centre, ſo that in moving the anterior portion, all the other parts are likewiſe in motion. Thus, when the pupilla is turned toward the noſe or upward, the

the inſertion of the optic nerve is at the ſame time turned toward the temple, or downward.

The uſe of the oblique muſcles is chiefly to counterbalance the action of the recti, and to ſupport the globe in all the motions already mentioned. This is evident from their inſertions, which are in a contrary direction to thoſe of the recti, their fixed points with relation to the motions of the globe being placed forward, and thoſe of the recti backward, at the bottom of the orbit. The ſoft fat which lies behind the globe is altogether inſufficient to ſupport it: Neither is the optic nerve more fit for this purpoſe; for I have ſhewn that this nerve follows all the motions of the globe, which would be impoſſible, were not the fat very pliable, and without reſiſtance. And to this we muſt add, that the optic nerve, at its inſertion in the globe, has a particular curvature, which allows it to be elongated, and conſequently prevents it from ſuffering any violence in the different motions of the eyes.

The obliquity of theſe two muſcles does not hinder them from doing the office of a fulcrum; becauſe this is not a fulcrum diſtinct from the part moved, or on which the globe of the eye ſlides like the head of one bone in the articular cavity of another; but, being fixed to the part, it eaſily accommodates itſelf to all the degrees of motion thereof. Had theſe muſcles lain in a ſtraight direction, they would have incommoded the recti; but their obliquity may be ſaid to be in ſome meaſure rectified by the inner ſurface of the orbit, and the abductor.

The inner ſurface of the orbit ſerves for a kind of collateral fulcrum, which hinders the globe from falling too far inward; as the joint action of the two obliqui prevents it, in part, from falling too far outward. The abductor, by being bent on the globe, not only hinders it from being carried outward, but alſo prevents the indirect motions of the obliqui from thruſting it out of the orbit toward the temples.

The other uſes attributed to theſe muſcles ſeem to be without foundation, from the conſideration of their inſertions, and of the ſtructure of the parts with which they are concerned; both which reaſons are explained in the Memoirs of the Academy for 1721.

§ 6. *The Supercilia, and Muſculi Frontales, Occipitales, and Superciliares.*

Supercilia. The ſupercilia, or eye-brows, peculiar to the human ſpecies, are the two hairy arches ſituated at the lower part of the forehead, between the top of the noſe and temples, in the ſame direction with the bony arches which form the ſuperior edges of the orbits. The ſkin in which they are fixed does not ſeem to be much thicker than that of the reſt of the forehead; but the membrana adipoſa is thicker than on the neighbouring parts. The colour of the eye-brows is different in different perſons, and often, in the ſame perſon, different from that of the hair on the head; neither is the ſize of them always alike. The hairs of which they conſiſt are ſtrong and rather ſtiff, and they lie obliquely, their roots being turned to the noſe, and their points to the temples.

The ſupercilia have motions common to them with thoſe of the ſkin of the forehead, and of the hairy ſcalp. By theſe motions the eye-brows are lifted up; the ſkin of the forehead is wrinkled more or leſs regularly and tranſverſely; and the hair and almoſt the whole ſcalp is moved, but not in the ſame degree in all perſons; for ſome people by this motion alone can move their hat, and even throw it off their head. The eye-brows have likewiſe particular motions which contract the ſkin above the noſe; and all theſe different motions are performed by the occipital, frontal, and ſuperciliary muſcles. (*See* Vol. I.)

The

The occipital and frontal muſcles appear to be true digaſtrici, both in regard to their inſertions and action. The fixed inſertions of the occipitales at the lower part of the occiput, and the moveable inſertions of the frontales in the ſkin of the forehead and of the ſupercilia, being well conſidered, together with their reciprocal inſertions in the ſame aponeuroſis, ſeem to be very convincing proofs that they are digaſtric muſcles.

Theſe four muſcles ſeem always to act in concert, the occipitales being only auxiliaries or aſſiſtants to the frontales, the office of which is to raiſe the ſupercilia by wrinkling the ſkin of the forehead; theſe wrinkles following the direction of the eye-brows regularly in ſome ſubjects, and very irregularly in others.

To be convinced of the co-operation of theſe four muſcles, we need only hold the hand on the occipitales, while we raiſe the eye-brows and wrinkle the forehead ſeveral times, and we ſhall perceive the occipitales to move each time, though not in the ſame degree in all ſubjects. In ſome perſons the occipitales ſeem to be relaxed, while the frontales being in contraction move the whole ſcalp and pericranium forward, and then contract to bring them back to their natural ſituation.

The action of the muſculi ſuperciliares is to depreſs the eye-brows, to bring them cloſe together, and to contract the ſkin of the forehead immediately above the noſe into longitudinal and oblique wrinkles, and the ſkin which covers the root of the noſe into irregular tranſverſe wrinkles. This action, as well as that of the frontales, and of the muſcles of the noſe and lips, is not always arbitrary, but ſometimes mechanical and involuntary. Theſe muſcles may perhaps likewiſe ſerve to keep the muſculi frontales in equilibrio during their inaction, they being moveable by both extremities.

§ 7.

§ 7. *The Palpebrae and Membrana Conjunctiva.*

Palpebrae. The palpebrae are a kind of veils or curtains placed tranſverſely above and below the anterior portion of the globe of the eye, and accordingly there are two eye-lids to each eye, the one ſuperior and the other inferior. The ſuperior is the largeſt and moſt moveable in man. They both unite at each ſide of the globe, and the places of their union are termed *angles*, one large and internal, which is next the noſe, the other ſmall or external, which is next the temples.

Structure of the palpebrae. The palpebrae are made up of common and proper parts. The common parts are the ſkin, epidermis, and membrana adipoſa. The proper parts are the muſcles, the tarſi, the puncta or foramina lacrymalis, the membrana conjunctiva, the glandula lacrymalis, and the particular ligaments which ſuſtain the tarſi. The tarſi and their ligaments are in ſome meaſure the baſis of all theſe parts.

Tarſi. The tarſi are thin cartilages, forming the principal part of the edge of each palpebra, and they are broader at the middle than at the extremities. Thoſe of the ſuperior palpebrae are a little more than a quarter of an inch in breadth; but in the lower palpebrae they are not above the ſixth part of an inch, and their extremities next the temples are more ſlender than thoſe next the noſe.

Theſe cartilages are ſuited to the borders and curvature of the eye-lids. The lower edge of the ſuperior cartilage, and the upper edge of the inferior, terminate equally, and both may be termed the *ciliary edges*. The oppoſite edge of the upper tarſus is ſomething ſemicircular between its two extremities; but that of the inferior tarſus is more uniform, and both are thinner than the ciliary edges. Their inner ſides, or thoſe next the globe, are grooved by ſeveral ſmall tranſverſe channels,

channels, of which hereafter; and the extremities of both cartilages are connected by a kind of small ligaments.

Ligamenta tarsorum lata. The broad ligaments of the tarsi are membranous elongations, formed by the union of the periosteum of the orbits and pericranium along both edges of each orbit. The superior ligament is broader than the inferior, and fixed to the superior edge of the upper cartilage, as the inferior is to the lower edge of the lower cartilage; so that these ligaments and the tarsi, taken alone, or without the other parts, represent palpebrae.

Membrana conjunctiva. The membrana conjunctiva is a thin membrane, one portion of which lines the inner surface of the palpebrae, that is, of the tarsi and their broad ligaments. At the edge of the orbit it has a fold, and is continued from thence on the anterior half of the globe of the eye, adhering to the tunica albuginea; so that the palpebrae and the fore-part of the globe of the eye are covered by one and the same membrane, which does not appear to be a continuation of the pericranium, but has some connection with the broad ligaments of the tarsi.

The name of *conjunctiva* is commonly given only to that part which covers the globe, the other being called simply *the internal membrane of the palpebrae*; but we may very well name the one *membra oculi conjunctiva*, and the other *membrana palpebrarum conjunctiva*. That of the palpebrae is a very fine membrane, adheres close to the palpebrae, and is full of small capillary blood-vessels. It is perforated by numerous imperceptible pores, through which a kind of serum is continually discharged; and it has several very evident folds, which shall be spoken to hereafter.

The conjunctiva of the eye adheres by the intervention of a cellular substance; and is consequently loose, and as it were moveable; and it may be taken hold of, and separated in several places from the tendinous coat. It is of a whitish colour;

colour; and being tranſparent, the albuginea makes it appear perfectly white: Theſe two coats together forming what is called *the white of the eye*. The greateſt part of the numerous veſſels which run upon it contain naturally only the ſerous part of the blood, and conſequently are not diſcoverable, except by anatomical injections, inflammations, obſtructions, &c. With the point of a good knife we continue the ſeparation of this membrane over the cornea.

Glandula lacrymalis. The lacrymal gland, the uſe of which, till of late years, was not known, is yellowiſh, and of the number of thoſe called *conglomerate glands*. It lies under that depreſſion obſervable in the arch of the orbit near the temples mentioned in the deſcription of the ſkeleton, and laterally above the globe of the eye. It is a little flatted, and divided, as it were, into two lobes; one of which lies toward the inſertion of the muſculus levator, the other toward the abductor. It adheres very cloſely to the fat which ſurrounds the muſcles and poſterior convexity of the eye, and it was formerly named *glandula innominata*.

From this gland ſeveral ſmall ducts go out, which run down almoſt parallel to each other, through the ſubſtance of the tunica interna or conjunctiva of the ſuperior palpebra, and afterwards pierce it inwardly near the ſuperior edge of the tarſus. Steno diſcovered the excretory ducts of this gland upon the eye of an ox; and they are painted by Bidloo 1661. In man, however, they are ſeen with more difficulty; for, although deſcribed by Winſlow and Lieutaud, they were unknown to later authors, as Morgagni, Zinn, and Haller, till Dr Monro, the preſent profeſſor, diſcovered and injected them before the year 1753. They are ſix or ſeven in number, have no communication with each other, and open upon the inner ſide of the upper eye-lid near the outer angle.

The

The borders of each palpebra, taken together, are formed by the edge of the tarſus, and by the union of the internal membrane with the ſkin and epidermis. This border is flat, and of ſome ſenſible breadth, from within about a quarter of an inch of the internal angle, all the way to the external angle, near which the breadth diminiſhes. This breadth is owing only to the thickneſs of the palpebrae, which at this place have their edges oblique or ſlanting, in ſuch a manner as when the two palpebrae touch each other ſlightly, a triangular ſpace or canal is formed between them and the globe of the eye.

Cilia. The flat edge of each palpebra is adorned with a row of hairs called *cilia*, or the *eye-laſhes*. Thoſe belonging to the ſuperior palpebra are bent upward, and are longer than thoſe of the lower palpebra which are bent downward. Theſe rows are placed next the ſkin, and are not ſingle, but irregularly double or triple. The hairs are longer near the middle of the palpebrae than toward the extremities; and, for about a quarter of an inch from the inner angle, they are quite wanting.

Glandulae ciliares. Along the ſame border of the palpebrae, near the internal membrane, or toward the eye, we ſee a row of ſmall holes, which may be named *foramina* or *puncta ciliaria*. They are the orifices of the ſame number of ſmall oblong glands wnich lie in the ſulci, channels, or grooves, on the inner ſurface of the tarſus. Theſe little glands are of a whitiſh colour; and, when examined through a ſingle microſcope, they appear like bunches of grapes, thoſe of each bunch communicating together; and, when they are ſqueezed between two nails, a ſebaceous matter, like ſoft wax, is diſcharged through the puncta ciliaria. They are more numerous in the upper than in the under eye-lids, and were firſt painted by Caſſerius, but afterwards deſcribed by Meibomius, by whoſe name they are frequently called.

Puncta

Puncta lacrymalia. Near the great or internal angle of the palpebrae, the flat portions of their edges terminate in another, which is rounder and thinner. By the union of these two edges an angle is formed; which is not perfectly pointed like a true angle, but rounded; and may be called *the internal* or *nasal angle.*

At this place, the extremity of the flat portion is distinguished from the round portion by a small protuberance or papilla, which is obliquely perforated by a small hole in the edge of each palpebra. These two small holes are very visible, and often more so in living than in dead bodies; and they are commonly named *puncta lacrymalia*, being the orifices of two small ducts, called *lacrymal*, which unite beyond the angle of the eye, and open a little below the upper end of a particular reservoir, termed *sacculus lacrymalis*, which shall be described with the *Nose.*

The puncta lacrymalia are opposite to each other, so that they meet when the eye is shut. Round the orifice of each of these points, we observe a whitish circle, which seems to be a cartilaginous appendix of the tarsus, and which keeps the orifice always open. These two oblique circles are so disposed, that, when the eye is but slightly shut, they touch each other only toward the skin, and not toward the globe of the eye. The fine membrane which covers these circles, and passes through the puncta into the ducts, seems sometimes to wrinkle when it is touched with a stilet. This observation was first made by M. Saint Yves, a Parisian oculist.

Caruncula lacrymalis. The caruncula lacrymalis is a small reddish granulated, oblong body, situated precisely between the internal angle of the palpebrae and globe of the eye, but it is not fleshy, as its name would insinuate. The substance of it seems to be wholly glandular; and it appears through a single microscope in the same manner as the other conglomerate

rate glands. We discover upon it a great number of fine hairs, covered by an oily yellowish matter, furnished by this gland; and, on the globe of the eye, near this glandular body, we see a semilunar fold formed by the conjunctiva, the concave side of which is turned to the uvea, and the convex side to the nose.

This fold, which has the name of *membrana semilunaris*, appears most when the eye is turned toward the nose; it is shaped like a crescent, the two points of which answer to the puncta lacrymalia, and conduct the tears into the puncta.

§ 8. *The Muscles of the Palpebrae.*

The muscles of the palpebrae are commonly reckoned to be two; one peculiar to the upper eye-lid, named *levator palpebrae superioris*; the other common to both, called *musculus orbicularis palpebrarum*, which has been subdivided by different authors in different manners. *See* Description of Muscles, Vol. I.

The skin of the superior palpebra is folded arch-wise, almost in a parallel direction to that of the semioval fibres; the plicae intersecting the levator, whereas the other folds only intersect the orbicularis. The radiated and oblique plicae seldom appear in young persons, except when the first and second portions of the orbicularis are in action; but in aged persons its marks are visible at all times.

In man, the superior palpebra has much more motion than the inferior. The small simple motions, called *twinkling*, which frequently happen, though not equally often in all subjects, are performed by the alternate contraction of the levator palpebrae and orbicularis.

These slight motions, especially those of the upper palpebra, are not very easy to be explained according to the true structure of the part. The motions which wrinkle the

palpebrae, and which are commonly performed to keep one eye very close shut, while we look stedfastly with the other, are explicable by the simple contraction of all the portions of the orbicularis. These motions likewise depress the supercilia, which consequently may be moved in three different manners, upwards by the musculi frontales, downward by the orbiculares, and forward by the superciliares.

§ 9. *The Vessels of the Eye, and its Appendages.*

The internal carotid artery, by means of the arteria maxillaris externa, and the temporal and frontal arteries, give several ramifications to the integuments which surround the eye, and to all the portions of the musculus orbicularis; and these ramifications communicate with those which are distributed to the membrana conjunctiva palpebrarum, and to the caruncula. Some small branches also come in through the spheno-maxillary suture, to be distributed chiefly on the periosteum of the orbit, and to the fat of the eye. The internal carotid artery having entered the cranium, sends off a considerable branch called the *ocular*, which accompanies the optic nerve, to be distributed to the muscles and globe of the eye, to the levator palpebrae, to the fat, glandula lacrymalis, membrana conjunctiva, caruncula lacrymalis, &c. It likewise communicates with the external carotid, and sends one or two very small branches to the nose. The branches which supply the globe of the eye have the name of *ciliares*; they perforate the back part of the tunica sclerotica in five or six places, after which they run a little way through its substance, where each branch forms a plexus, which sends numerous branches to the choroides.

Dr Wrisberg observes, they next perforate the external lamina of the choroides, and form, between that and the internal lamina, the vascular stellae mentioned in the description

tion of this internal lamina. Some ſmall vaſcular filaments from theſe ramifications, are likewiſe obſerved to adhere very cloſely to the tunica vitrea; and they ſend, in a direct courſe to the circumference of the iris, ſome ſmall arteries, which there form a vaſcular circle that gives capillaries to the membrana cryſtallina. Theſe veſſels may be eaſily injected in new born children. The poſterior part of the capſule of the lens is ſupplied from another ſource: Albinus, and after him many others, have injected, in a foetus, a branch from the arteria centralis retinæ, which paſſes through the middle of the vitreous humour, and is diſperſed in a radiated manner on the back part of the capſula cryſtallina. Zinn is of opinion that theſe veſſels paſs alſo into the body of the lens; but of this ſufficient proofs are wanting.

The veins of all theſe parts anſwer nearly to the arteries; thoſe of the globe of the eye are called *vaſa vorticoſa*. The internal veins unload themſelves, partly into the internal jugular vein, by the ſinus cavernoſi; and partly into the external jugular vein, by the vena angularis, or maxillaris externa, the maxillaris interna, temporalis, &c.

Beſides the capillary veſſels, eaſily diſtinguiſhable by the red colour of the blood, there are great numbers of thoſe which admit nothing but the ſerous and lymphatic parts of the blood, and conſequently do not appear in the natural ſtate. They become viſible in ſome places by inflammations and injections, as on the membrana conjunctiva of the eye; but theſe contrivances do not diſcover them every where in aged perſons. In a foetus, and in new born children, ſays Winſlow, a fine injection has ſucceeded ſo well as to diſcover the veſſels of the membrana cryſtallina and vitrea; and in a foetus of about ſix months, the injected liquor ſeemed to me to have penetrated a part of the cryſtalline and vitreous humour.

§ 10.

§ 10. *The Nerves of the Eye and of its Appendages.*

Besides the optic nerve already described, the globe of the eye receives several small ones, which run on each side along and about the optic nerve, from its entry into the orbit to its insertion in the globe. These filaments come chiefly from a small lenticular ganglion, formed by very short rami of the orbitary or ophthalmic branch of the fifth pair, and by a branch of the third pair, or motores oculi.

The nerves of the lenticular ganglion having reached the globe of the eye, are divided into five or six fasciculi, which having surrounded the optic nerve, and penetrated and perforated the sclerotica, run at distances more or less equal between the sclerotica and choroides towards the iris. There each of them is divided into several short filaments, which terminate in the substance of the iris. These small nerves, which run from behind forward, between the sclerotica and the choroides, have formerly been taken for particular ligaments by anatomists of considerable eminence, but are now known under the name of *ciliary nerves*.

The nerves which go to the other parts belonging to the eye, come from the third, fourth, sixth, and first two branches of the fifth pair of nerves, and likewise from the portio dura of the seventh pair. The third, fourth, and sixth pairs give nerves to the muscles of the globe of the eye. The two branches of the fifth pair, and the portio dura of the seventh, give nerves not only to the other parts which surround the globe, but also to the musculi frontales and internal parts of the nose.

The trunk of the third pair, or motores oculi, having entered the orbit through the superior orbitary fissure, or foramen lacerum of the sphenoid bone, produces four branches. The first runs upwards, and divides into two; one for the musculus levator oculi, and the other for the levator palpebrae superioris. The trunk continuing its course, gives off the second

cond ſhort branch to the depreſſor oculi. The third branch is long, and goes to the obliquus inferior, contributing likewiſe to the formation of the lenticular ganglion already mentioned. The fourth branch is large, and ſupplies the adductor oculi.

The firſt branch of the fifth pair, commonly termed *nervus ophthalmicus*, divides into three rami, as it enters the orbit, and ſometimes only in two, one of which is afterwards ſubdivided. Of theſe three branches one is ſuperior, and termed *nervus ſuperciliaris*; one internal, termed *naſalis*; and one external, to which the name of *temporalis* or *lacrymalis* is applied.

The ſuperior or ſuperciliary ramus runs along the whole perioſteum of the orbit; and having paſſed through the ſuperciliary notch or foramen of the os frontis, is diſtributed to the muſculus frontalis, ſuperciliaris, and ſuperior portion of the orbicularis palpebrarum; and it communicates with a ſmall branch of the portio dura of the ſeventh pair.

The internal or naſal branch paſſes under the ramification of the nerve of the third pair; and running toward the noſe, is diſtributed partly on it, and partly on the neighbouring parts of the orbicularis, the caruncula, &c. This branch ſends off a filament, which, paſſing through the internal anterior orbitary hole, enters the cranium, and preſently returns through one of the ethmoidal holes to the internal parts of the noſe. Sometimes this naſal ramus communicates with the ramus ſuperciliaris by a particular arch, before it enters the orbitary hole.

The external or temporal ramus, which is ſometimes a ſubdiviſion of the ſuperciliaris, is diſtributed to the glandula lacrymalis, and ſends off a filament which pierces the orbitary apophyſis of the os malae.

The ſecond branch of the fifth pair, called *nervus maxillaris ſuperior*, ſends off a ramus through the bony canal of the lower

lower part of the orbit, which, going out at the anterior inferior orbitary hole, is diſtributed to the neighbouring portion of the muſculus orbicularus, and communicates with a ramus of the portio dura. The reſt of the ſuperior maxillary nerve ſhall be deſcribed afterwards.

The portio dura of the ſeventh pair, or auditory nerve, gives branches to the ſuperior, inferior, and external lateral parts of the orbicularis palpebrarum; one of which communicates with the nervus ſuperciliaris, and another with the ſub-orbitarius, to be afterwards deſcribed.

§ 11. *Sight.*

THE eye is the organ of viſion. The greater part of it is compoſed of pellucid humours capable of refracting the rays of light. The complexity of this organ is neceſſary for the defence of its tender parts; and the diverſity of the ſeveral humours, together with the various offices which this curious machine performs, neceſſarily required a very compound inſtrument.

Outwardly, a defence is afforded to this organ by the eye-brow or *ſupercilium*; and the thick hairs placed there, which are capable of being pulled down by the action of the frontal, corrugator, and orbicular muſcles afford a ſhade to the eye in too ſtrong a light. A depreſſion of the eye-brow ſerves alſo to expreſs concern of the mind, as an elevation of it denotes the mind to be in a ſerene quiet ſtate. This guard alſo conduces to throw off the ſweat and retained duſt, or the inſects which might fall into the eye.

The palpebrae are the peculiar guards of the eye; and that they might ſhut the more exactly for the defence of this ſenſible and delicate organ, their margins are furniſhed with cartilaginous arches, which, accurately correſponding with each other, form a tight and unwrinkled ſuture. The cartilage of each alſo hinders it from being drawn into wrinkles,

kles, while it is either elevated or depreſſed. The elevation of the upper eye-lid is performed by a muſcle ariſing from the involucrum of the optic nerve gradually ſpreading, and extending by its expanſion to the tarſus. This elevator is conſiderably aſſiſted in its action by the frontalis, and by various connections with the orbicularis when this laſt is drawn up or dilated by the former. The upper eye-lid is depreſſed by the *orbicularis* muſcle, which alſo ſerves to elevate the lower eye-lid, and covers the eye in ſuch a manner that no duſt or light can enter it in ſleep. The lower eye-lid is depreſſed by a double portion of the fibres, inſerted into the upper-lip.

Finally, that the protuberant margins of the eye-lids might not injuriouſly beat againſt each other, the *cilia* are placed ſo as to make a blind or ſhade, which, by excluding the extraneous rays, might afford a more diſtinct repreſentation of any object.

That the eye lids rubbing againſt each other might not grow together, they are ſupplied with a row of *ſebaceous glandules*, that diſcharge a ſoft liniment, which mixes and waſhes off with the tears.

The perpetual attrition of the eye-lids aſcending and deſcending againſt the globe of the eye, is prevented by the *tears*; which preſerve alſo the tenderneſs of the membranes and of the cornea, and ſerve to waſh out any inſects or other ſharp corpuſcles. Theſe form a ſaline pellucid liquor that may be evaporated, and never ceaſes to be poured over the anterior ſurface of the eye; but never runs over the cheeks, unleſs collected, by a foreign cauſe, in larger than uſual quantity. This liquor is exhaled partly from the arteries of the conjunctiva, and partly proceeds from the lacrymal gland.

The ſeparation of the tears is increaſed by the more frequent contraction of the orbicular muſcle, either from irritation, or ſome ſorrowful paſſion; by which means the tears are urged over, and waſh the whole ſurface of the eye and conjunctiva.

After

After the tears have performed their office, part of them fly off into the air; and the reſt, that they might not offend by their quantity, are propelled by the orbicular muſcle, towards its origin near the noſe, to the loweſt part of the palpebral margins, which, wanting the tarſus in this place, do not, on that account, exactly meet together. Here the caruncula lacrymalis interpoſes, and prevents the meeting of the eye-lids, at the ſame time furniſhing a liniment to thoſe parts which have no Meibomian ducts. Before this part is extended a ſmall portion, like a little eye-lid; which, deſcending perpendicularly, joins the true eye-lids, and is larger in beaſts than in men: But, at the beginning of this ſpace, between the eye-lids, appears the *punctum lacrymale*, which drinks up the tears from the ſinus in which they are collected, partly by tubular attraction, and partly by impulſe from the orbicular muſcle. If theſe points or openings are obſtructed, the tears run over and excoriate the cheek.

From both points proceeds a ſmall duct; theſe join together, and are inſerted by two mouths near the uppermoſt parts of the *lacrymal ſac*, which deſcends a little backward into the nares, opening there by an oblique oblong aperture at the bottom of the meatus, covered by the lower os ſpongioſum. Through this paſſage the ſuperfluous tears deſcend into the noſe, which they in part moiſten. A muſcle is by ſome writers aſcribed to this ſac; but it is not yet ſufficiently confirmed. Some late authors have compared the lacrymal ſac to the bladder of urine, which retains its contents for a conſiderable time, till it is thrown out, the ſphincter being relaxed. A ſimilar ſphincter has been aſcribed to the naſal duct, which is ſometimes ſhut and again relaxed, that the tears collected in the ſac may run out through the noſtrils.

The globe of the *eye*, compreſſed before, but longer than it is broad, is ſeated in the cavity of a bony orbit, larger than the eye itſelf; the exceſs is on all ſides occupied by a very ſoft

ſoft fat, ſurrounding the globe of the eye, and allowing it a free motion within the orbit.

Among the coats of the eye, the iris is the only one poſſeſſing motion. Though it has little ſenſation, and is not endowed with any mechanical irritability; yet, in a living man, quadruped, or bird, it is contracted on every greater degree of light, and is dilated on every ſmaller one; hence it is rendered broader for viewing diſtant objects, and narrower for viewing ſuch as are near. The cauſe of this dilatation ſeems to be a remiſſion of the powers reſiſting the aqueous humour; an argument of which is the dilatation of the pupil, occaſioned by debility, or ſucceeding ſyncope and death. The contraction is more obſcure, and perhaps only depends on the ſtronger afflux of humours into the colourleſs converging veſſels of the iris; ſo that this motion has ſomething in common with a beginning inflammation. In an animal twenty or thirty hours dead, Dr Haller has ſeen the radii of the iris extend by heat, and ſhut the pupil.

We are as yet unacquainted with the origin of the black pigment; nor can any glandules be found, which ſome authors have aſſigned for its ſeparation. Among its other uſes, one ſeems to be, to keep the cryſtalline lens firm. In infants, this ſame mucus has the image of a radiated flower behind the ciliary proceſs.

The *retina*, which is a continuation of the medulla from the optic nerve, immediately embraces the vitreous humour. Dr Haller ſays, that it extends to the ſurface of the cryſtalline lens; while Dr Monro obſerves, that it ends ſome way behind the ciliary circle.

Before we can attain any ſatisfactory knowledge of the nature of viſion, it will be neceſſary to point out ſome of the properties of light. Light is an extremely ſubtile fluid, penetrating with facility bodies of the cloſeſt texture, and greateſt denſity in a rectilineal direction, with the amazing veloci-

ty of ten millions of miles in a minute. Every luminous body has the peculiar property of ſending forth rays of light in every poſſible direction, which falling on the ſurfaces of ſurrounding objects, are reflected thence to our eyes. Hence the colour and form of the object become known. Each ray, ſo extremely ſmall as to have ſcarce any conceivable thickneſs, is ſeparable into ſeven permanent and immutable rays of a leſſer kind, namely red, orange, yellow, green, blue, indigo, and violet. Theſe rays are of different degrees of refrangibility, in the order in which they are enumerated, the red rays being moſt refrangible; and, when they are variouſly compounded, they conſtitute the different apparent colours of bodies.

The colours which ſeem peculiar to certain bodies may be thus explained: The ſurfaces of bodies, on which a whole ray of light falls, have, by ſome peculiar form or conſtruction, the power of reflecting ſome of the primitive rays, and abſorbing the others. If, for example, the ſurface is ſo denſe as to reflect all the primitive rays, the body appears white; if the ſurface reflects only the red rays, the body appears red, and ſo of others with their combinations. Thoſe bodies are opake which retain the rays within their ſubſtance, without permitting any to paſs through them; but theſe which ſuffer the rays of light to paſs through them, are called tranſparent or pellucid.

Rays of light falling perpendicularly on the ſurface of a tranſparent body, paſs through the body without changing their direction; but rays falling obliquely on the ſurface paſs through the body with a change of their direction nearer to the perpendicular; and this change of direction is called *refraction*. All tranſparent ſubſtances are, in optics, called *refracting mediums*. In general, the denſer the medium, the more the rays are bent towards the perpendicular; excepting only inflammable liquors, which, by a peculiar property, draw the rays more to a perpendicular than in proportion to

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the denſity of the liquor. The angle which the oblique ray makes with the perpendicular, is called the *angle of incidence*; and, after having been bent by entering the medium, the angle it then makes with the perpendicular is called the *angle of refraction*. We have hitherto conſidered the rays as paſſing out of void ſpace, or vacuum, into a refracting medium; but moſt of the rays we have occaſion to conſider paſs out of one refracting medium into another. If the ray paſs from a leſs into a more denſe medium, it is refracted, as if it had paſſed out of vacuum; but, if it paſs out of a denſer into a rarer medium, it is bent from the perpendicular. The proportions of the angles of incidence to thoſe of refraction, are obſerved to be conſtant enough; the ſine of the angle of refraction from air into water is to the ſine of the angle of incidence as 3 to 4; and, in paſſing from air into glaſs, the ſine of the angle of incidence is to the ſine of that refraction as 17 to 11; and from water into glaſs, as 51 to 44.

Rays that are parallel to one another, falling on a ſpherical tranſparent body, if the angle of incidence be greater than 48½ degrees, are reflected, and do not enter the ſphere; but, if that angle be leſs than 48½, they enter the ſphere, and are refracted, ſo as all to meet in one point, called the *focus*.

The rays of light, therefore, whether direct or inflected, fall upon the tunica cornea of the eye, ſo as to form a very ſharp cone between the lucid point and the membrane upon which they are ſpread; the baſis of which cone will be the ſurface of the cornea, and the apex the radiant point; yet ſo that all rays may, without any ſenſible error, be reckoned parallel with each other. Among theſe, there are ſome rays reflected back from the cornea, without ever penetrating the ſurface; namely, all ſuch as fall upon that membrane in a greater angle than that of forty degrees. Others, which enter the cornea at very large angles, but leſs than the former,

and

and fall in betwixt the iris and the ſides of the cryſtalline lens, are ſuffocated or loſt in the black paint that lines the iris and the ciliary proceſſes; but thoſe rays only fall upon the ſurface of the lens which enter the cornea at ſmall angles, not much diſtant from the perpendicular, or, at moſt, not exceeding twenty-eight degrees. By this means, all thoſe rays are excluded which the refracting power of the humours of the eye could not be able to concentrate or bring together upon the retina; without which they would paint the object too large and confuſedly.

The rays falling on the cornea are therefore refracted, and paſs through the aqueous humour in a more parallel, or perhaps converging direction, by which contrivance a greater number of rays fall on the cryſtalline than if they had not previouſly paſſed through the cornea and the aqueous humour.

In the cryſtalline lens, and more eſpecially in its poſterior very convex ſide, the rays will converge greatly, and paſs thence into the vitreous body.

This vitreous body continues to bend the rays a little more gently towards the perpendicular, till at length the rays coming from the point of diſtinct viſion, are concentrated into a very ſmall part of the retina, where they paint an image of that object from whence they come, but in a poſition inverted, from the neceſſary decuſſation or croſſing of the rays. The manner in which the images of objects are thus painted, may be ſeen experimentally in an artificial eye, or in a natural eye when the back part of the ſclerotica is cut off, and a piece of paper placed to receive the object. The image is painted on the retina at the end of the viſual axis, which is ſituated on the exterior ſide of the place where the optic nerve enters the ſclerotica; it is not, however, a mere point, but has ſome degree of breadth, ſince we ſee many objects at once, whoſe images muſt be in diſtinct points of

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the painted field. And there an object is seen most distinctly, because the rays arrive thither nearly perpendicular. But frequently this point of vision does not fall on the same place on both of the eyes. When the lens has been couched or displaced, the vitreous body, although it has a weaker refracting power, usually suffices to bring the visual rays together to a focus.

Is it altogether false that the object is painted on the retina? Or is this picture made on the choroides? Is this last opinion confirmed by an experiment which proves that the place where the optic nerve enters is blind, and which is thus explained, that there is in that place no choroides but the bare retina, and that thence there is no vision? But this is repugnant to a very well known observation, namely, that the retina is a most sensible nervous medulla; and that the choroides consists only of a few small nerves, and almost entirely of vessels most certainly blind. It is likewise contradicted by the very great apparent differences observable in the choroides of different animals, and by the perfect sameness of the retina in all, and also by the black spots on the retina, which always produce partial blindness. This experiment shews also the reason why the optic nerve is not inserted into the axis of the eye, but into its side. Thus, except only in one single case, namely, when the object is in the concourse of the lines drawn through the centre of the optic nerves, the one eye sees, and assists the other, which has the centre of its optic nerve turned to the object.

Since the necessary offices of human life require a distinct object to be painted upon the retina, not only by the rays which come from one certain distance, but likewise by rays which come from very different parts more or less distant; it has therefore been thought that a necessary change, produced by its own causes, is made on the eye. Other eminent anatomists have supposed the lens moveable by the powers before mentioned.

mentioned. This art of seeing distinctly at different distances is said to be learned by experience, it being unknown to those who have been lately couched. It is also said, that, in an artificial eye, the use and necessity of this motion may be plainly perceived. Too great a divergency of the rays, as in those which come from objects very close to the eye, is corrected by a removal of the lens farther from the retina, so as to bring the focus upon the retina itself, which would otherwise have fallen behind the eye; for, the refracting power of the eye being the same, if the focus of rays coming from the distance of three feet fall perfectly upon the retina, those rays which come from the distance of three inches will not be collected into a focus at the retina, but beyond it; and rays still more diverging will meet together yet farther behind the eye, if they are not collected together by a greater refracting power.

But those rays which come from very remote objects, and which may therefore be counted parallel, will meet together before the retina, in the vitreous humour, and separate again at their point of concourse, as if it was a lucid point: To remedy which, therefore, it is supposed that those powers above mentioned, remove the crystalline lens back from the cornea nearer to the retina, that the rays may form the focus on the retina: For an eye that will collect the rays coming from seven inches, so as to unite them on the retina, will collect those together before the retina which come from a distance of three feet. It was therefore perfectly necessary for the eye to be made thus changeable, that we might be able to see distinctly at various distances. The point of distinct vision is in that part of the retina where the given object is painted in the least compass possible. The powers causing the visual rays to unite on the retina, are often very different in the two eyes of the same person, the one being long-sighted and the other short sighted.

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Theſe, and other commonly received opinions, are taught by mathematicians, who more readily perceive the neceſſity of theſe changes. But yet there is no power in the human eye which can either move the cryſtalline humour out of its place, or compreſs it: Beſides, we do not perceive this faculty in ourſelves; for we move a book nearer to our eyes when it is too far off, ſo as to appear confuſed, which we would have no occaſion to do, if by changing the internal figure of the eye we could correct the fault of the diſtance: And through a ſmall hole, we perceive an object ſingle, only in the point of diſtinct viſion, but double in every other. Perhaps the contraction of the pupil may enable us to ſee near objects more diſtinctly.

This contraction, however, is not in all people ſufficient for the purpoſe. There are ſeveral people, eſpecially ſuch as lead a ſedentary life, and ſuch as are employed in examining minute objects, whoſe cornea is too convex and denſe, whoſe cryſtalline lens is too gibbous and ſolid, and whoſe eye is lengthened by the incumbent weight of the humours, and perhaps the humours themſelves are too denſe; and in the ſame perſon the eye may probably have all theſe defects joined together. People labouring under one or more of theſe inconveniencies have an iris that is ſenſible in a very ſmall degree of light, which circumſtance makes them twinkle with the eye-lids when they are in a ſtrong light, and they are called *myopes* or ſhort-ſighted. In theſe, the point of diſtinct viſion is very near to the eye, commonly from one to ſeven inches from the cornea; but they ſee remoter objects more obſcurely, without being able to diſtinguiſh their parts. The reaſon of this is evident; ſince, from the fore-mentioned cauſes, there is a greater refracting power of the humours, by which the diſtant, and conſequently parallel, rays are obliged to meet in their focus before the retina, from whence ſpreading again, they fall upon the retina in many points.

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On the contrary, to a good eye, objects which are too near the cornea appear confused; because the rays coming from them are spread over several parts of the retina, and are not collected in a point on it.

The remedy for this fault in the sight is to correct it in its beginning, by looking at distant, rather than near and minute objects; by the use of concave glasses, or by viewing things through a small hole, by which the light is weakened. When the disorder is confirmed, the remedy is a concave lens, which takes off a degree of the refracting power in the humours, cornea, and crystalline lens, in proportion as it is more concave; by which means the focus of rays from remote objects is removed farther behind the cornea, so as to fall upon the retina. This glass ought to be a portion of a sphere, whose diameter is equal to the square of the distance of distinct vision from the naked eye, multiplied by the distance of distinct vision in the armed eye, and that product divided by the difference between them. Age itself advancing, gives some relief to the short-sighted, for children are mostly near-sighted; but, as the eye grows older it becomes flatter, in proportion as the solids grow stronger; and, contracting to a shorter axis, the refracting powers of the lens and cornea are diminished.

The other disorder of the sight, contrary to the former, troubles people who often look at very distant objects, and is more especially familiar and incurable in old people. In such, the cornea and crystalline lens are flatter, and the humours of the eye have a less refracting power. Hence near objects, whose rays fall very diverging upon the cornea, appear confused; because the converging or refracting powers of the eye are not sufficient to bring the rays together in a focus upon the retina; but the rays go on scattered beyond the retina, and throw the point of their pencil behind the eye, from whence vision is confused. The point of distinct vision among

among presbyopi, or old or long sighted people, is from the distance of fifteen inches to three feet.

Such persons are, in some measure, relieved by looking through a black tube held before the eye; by the use of which the retina grows tenderer, and the rays come to the eye in a parallel direction. The remedy here is a convex lens, which causes the rays to converge and unite together sooner in a focus, that it may not fall behind the eye, but upon the retina. The diameter of the sphere, of which such a lens ought to be a portion, is determined as before. There is no hope of relief from age, which increases the malady.

The medium between the short and long-sighted eye is the best, by which a person can see distinctly enough objects that are both near and remote; and of this kind we reckon an eye that is able to read distinctly at the distance of one foot. But a good eye requires other necessary conditions, such as a perfect clearness of the humours; a due mobility of the eye itself, and its parts; a sensibility of the pupil, and a retina neither too prurient nor too callous.

The mind only receives a representation of the image of the object by the eye, impressed on the retina, and transferred to the common sensory or seat of the soul. Several circumstances relative to vision are not determined by the instrumentality of the eye, but are perceived by the mind from mere experience; and sometimes the mind interprets the representation to be very different from that which the eye gives to her. The magnitude of an object, for instance, is not determined by the eye, but by the optical angle, which is formed by lines supposed to be drawn from the extremities of the object to the cornea. Hence near objects seem large, and those at a distance small. On this circumstance also the power of microscopes depends, which magnify in proportion to the difference between the focal length of the magnifier

and the diſtance of diſtinct viſion. Objects, by the means of this inſtrument, not only appear larger, but brighter and more diſtinct, and hence the mind thinks them nearer.

The brightneſs of objects ſituated in the ſame light depends partly on the ſize of this ſame angle, partly on the number of rays which they reflect, and partly on the ſmallneſs of the picture on the retina; hence near objects appear bright, while thoſe that are more remote ſeem obſcure; and hence alſo, when remote objects are more enlightened, the mind ſuppoſes them either greater or nearer than they really are.

The apparent place of an object, ſeen with one eye, is in the line which divides the optical angle. But, if we look at an object with both eyes, its apparent place will be in the point where lines, drawn through the axes of both eyes to the object, meet.

Diſtance we cannot perceive; and if a blind man, who never ſaw, ſhould by any means be reſtored to ſight, he would imagine every thing he ſaw to touch his eyes. Even we, who are accuſtomed to judge by ſight, make many fallacious conjectures concerning the diſtance of objects. We judge of the diſtance of an object from the diminution of its known bulk; from its diminiſhed brightneſs; from the faintneſs of its image, by which we are leſs capable of diſtinguiſhing its parts; and, laſtly, from the number of bodies, whoſe diſtance is known, that are interpoſed between us and the object.

A body does not ſeem convex, until we have learnt by experience, that a body, which is convex to the feeling, cauſes light and ſhadow to be diſpoſed in a certain manner. Hence it is, that microſcopes frequently pervert the judgment, by tranſpoſing or changing the ſhadows. The ſame alſo happens in that phenomenon which is not yet ſufficiently underſtood,

ſtood, by which the concave parts of a ſeal are made to ſeem convex, and the contrary.

The viſible *ſituation* of the parts of an object, is judged by the mind to be the ſame with that which theſe parts naturally have in the object, and not the inverted poſition in which they are painted upon the retina. The faculty of correcting this inverſion ſeems to be innate; for new-born animals always ſee objects upright; and men who have been born with cataracts are obſerved, upon couching the cataracts, to ſee every thing in its natural ſituation, without the uſe of any feeling, or previous experiences.

The mind is often impoſed on by the continuance of the ſenſation after it has been conveyed to the mind, by which means objects, although inſtantly removed, continue to be ſeen for about a ſecond. Hence proceeds the idea of a fiery circle from the circumrotation of a lucid body; and hence alſo proceeds the continuance of the ſhining image of the ſun, and ſometimes of other bodies, after they have been viewed by the eye.

Do we diſtinctly perceive only one object ſituated in the axis of diſtinct viſion? And does the eye perſuade itſelf, that it ſees many objects at a time, partly from the duration of the ideas, and partly from the quickneſs of the motions of the eye? In diſtinct viſion, we may certainly anſwer theſe queſtions in the affirmative, but not in more imperfect viſion. Why do we ſee only one object with two eyes? becauſe, when the impreſſions of two objects are ſimilar, the ſenſation becomes ſingle. Even without the concourſe of optic nerves, inſects who have numerous eyes perceive objects ſingle. Hence the images of two objects excite only one ſenſation, when they fall upon the ſame point of the retina; but two ſenſations ariſe from one object, when the images fall upon different parts of the retina. Whence proceed diurnal and nocturnal blindneſs? The former is common to many nations

living

living in the warmeſt climates, under the brighteſt ſun, and to old men. The other happens in inflamed eyes, and to young men of a hot temperament, who are endowed with eyes vaſtly ſenſible. Whence do animals ſee in the dark? From a large dilatable pupil, and tender retina; and a ſhining choroides, which reflects the light very ſtrongly. Why are we blind when brought out of a ſtrong light into a weak one? Becauſe the optic nerve, having ſuffered the action of ſtronger rays of light, is incapable of being moved by thoſe that are weaker. Whence have we a pain, by paſſing ſuddenly from a dark place into the light? Becauſe the pupil, being widely dilated in the dark, ſuddenly admits too great a quantity of light before it can contract; whence the tender retina, which is eaſily affected by a ſmall light, feels, for a time, an impreſſion too ſharp and ſtrong. Whether do we ſee with one eye, or with both? Moſt frequently with one, and more eſpecially the right eye: But, when both are employed together, we ſee more objects, and more plainly; and we alſo diſtinguiſh more points of the ſame object, and judge better of their diſtances.

Sect. III. The Nose.

The parts of which the noſe is compoſed, may be divided in two different ways, viz. from their ſituation, into external and internal parts; and, from their ſtructure, into hard and ſoft parts.

The external parts are the root of the noſe, the arch, the back or ſpine of the noſe, the ſides of the noſe or of the arch, the tip of the noſe, the alae, the external nares, and the part under the ſeptum.

The internal parts are the internal nares, the ſeptum narium, the circumvolutions, the conchae ſuperiores, or oſſa ſpongioſa ſuperiora, conchae inferiores, the poſterior openings of the

the internal nares, the ſinus frontales, ſinus maxillares, ſinus ſphenoidales, the ductus lacrymales, and ductus palatini.

The firm or hard parts are moſtly bony, and the reſt cartilaginous, viz. the os frontis, os ethmoides, os ſphenoides, oſſa maxillaria, oſſa naſi, oſſa unguis, oſſa palati, vomer, conchae inferiores, and the cartilages. To theſe we may add the perioſteum and perichondrium, as parts belonging to the bones and cartilages.

The ſoft parts are the integuments, muſcles, ſacculus lacrymalis, membrana pituitaria, veſſels, nerves, and hairs of the nares. The bony parts have been all explained in the deſcription of the ſkeleton; and therefore we need only in this place notice their diſtribution and diſpoſition, as far as relates to the formation of ſome of the principal parts. The ſeptum is formed by the deſcending lamina of the os ethmoides, and by the vomer; and it is placed in the groove framed by the criſtae of the oſſa maxillaria, and riſing edges of the oſſa palati. The fore part of the noſe is formed by the oſſa naſi; and the ſides, by the ſuperior apophyſes of the oſſa maxillaria.

The internal nares, or the two cavities of the noſe, comprehend the whole ſpace between the external nares and poſterior openings, immediately above the arch of the palate, from whence theſe cavities reach upward as far as the lamina cribroſa of the os ethmoides, where they communicate forward with the ſinus frontales, and backward with the ſinus ſphenoidales. Laterally, theſe cavities are bounded on the inſide by the ſeptum narium; and on the outſide, or that next the cheek, by the conchae or oſſa ſpongioſa, between which they communicate with the ſinus maxillaris.

The particular ſituation of theſe cavities deſerves our attention. The bottom of them runs directly backward, ſo that a ſtraight and large probe may eaſily be paſſed from the external nares, under the great apophyſis of the occipital bone.

bone. The openings of the maxillary ſinuſes are nearly oppoſite to the upper edge of the oſſa malarum. The openings of the frontal ſinuſes are more or leſs oppoſite to and between the pulleys or rings of the muſculi trochleares; and by theſe marks the ſituation of all the other parts may be determined.

The inferior portion of the external noſe is compoſed of ſeveral cartilages, which are commonly five in number, and nearly of a regular figure. The reſt are only additional, ſmaller, more irregular, and the number of them more uncertain. Of the five ordinary cartilages, one is ſituated in the middle, the other four laterally. The middle cartilage is the moſt conſiderable, and ſupports the reſt, being conducted immediately to the bony parts; but the other four are connected to the middle cartilage, and to each other, by means of ligaments.

The principal cartilage of the noſe conſiſts of three parts, one middle, and two lateral. The middle portion is a broad cartilaginous lamina, joined, by a kind of ſymphyſis, to the anterior edge of the middle lamina of the os ethmoides, to the anterior edge of the vomer, and to the anterior part of the groove formed by the oſſa maxillaria, as far as the naſal ſpines of theſe bones. This lamina completes the ſeptum narium, and indeed forms its principal part.

The lateral portions are oblique and narrow, ſuited to the correſponding parts of the bony arch. Where they join the middle lamina, a ſuperficial groove is obſervable, which makes them ſometimes appear like two diſtinct pieces, ſeparated from the lamina, though they are really continuous. This ſhallow groove terminates below by a ſmall criſta.

The lateral cartilages are two, on each ſide of the inferior part of the lamina; one anterior, the other poſterior. The two anterior cartilages are very much bent forward, and form what is called the *tip of the noſe*; the ſpace between their incurvated

curvated extremities being commonly filled with a kind of fatty ſubſtance. The two poſterior cartilages form the alae of the nares, being pretty broad, and of an irregular figure.

The ſpaces left between ſome portions of the anterior and poſterior cartilages, thoſe between the poſterior cartilages and the neighbouring parts of the offa maxillaria, and laſtly thoſe between theſe four lateral cartilages and the principal lamina, vary in different ſubjects, and are filled by ſmall additional cartilages, the number, ſize, and figure of which, are as various as the interſtices in which they lie.

The ſub-ſeptum, or portion under the ſeptum narium, is a pillar of fat applied to the interior edge of the cartilaginous partition, in form of a ſoft moveable appendix. The thickneſs of the alae narium, and eſpecially that of their lower edges, is not owing to the cartilages, which are very thin, but to the ſame kind of ſolid fat with which theſe cartilages are covered. The great cartilage is immoveable, by reaſon of its firm connection to the bony parts of the noſe; but the lateral cartilages are moveable, becauſe of their ligamentous connections, in different manners, by the muſcles belonging to them.

The external noſe is covered by the common integuments, the ſkin, epidermis, and fat. The parts which cover the tip of the noſe and alae narium, are pierced with the ducts of a great number of glandulae ſebaceae, the contents of which may eaſily be ſqueezed out by the fingers. All theſe bony and cartilaginous parts have likewiſe the common perioſteum or perichondrium.

Muſcles of the noſe. Six muſcles are commonly reckoned to belong to the noſe; two levatores, two depreſſores, and two compreſſores. In very muſcular bodies, there are likewiſe ſome ſupernumerary muſcles, or ſmaller acceſſorii. The noſe may alſo be moved, in ſome meaſure, by the neighbouring

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ing muſcles, which, in many caſes, become aſſiſtants to the proper muſcles of this organ.

The firſt pair of theſe muſcles raiſes and dilates the alae of the nares when they act. They likewiſe wrinkle the ſkin on the ſides of the noſe. The ſecond pair have the contrary effect; and the third pair compreſs the ſides of the noſe to the ſeptum, as in ſmelling.

Membrana pituitaria. The membrana pituitaria is that which lines the whole internal nares, the oſſa ſpongioſa, the ſides of the ſeptum narium, and, by an uninterrupted continuation, the inner ſurface of the ſinus frontales and maxillares, and of the ductus lacrymales, palatini, and ſphenoidales. It is likewiſe continued down from the nares to the pharynx, ſeptum palati, Euſtachian tubes, &c. as we ſhall ſhew hereafter. It is likewiſe known by the name of *Schneideriana*, from the anatomiſt who has given a deſcription of it.

It is termed *pituitaria*, becauſe through the greateſt part of its large extent, it ſerves to ſeparate from the arterial blood a mucilaginous lymph, called *pituita* by the ancients, which, in its natural ſtate, is nearly liquid; but it is ſubject to very great changes, becoming ſometimes glutinous or ſnotty, ſometimes limpid, &c.; neither is it ſeparated in equal quantities through the whole membrane.

When we carefully examine this membrane, it appears to be of a different ſtructure in different parts. Near the edge of the external nares it is very thin, appearing to be the ſkin and epidermis in a degenerated ſtate. All the other parts of it, in general, are ſpongy, and of different thickneſſes. The thickeſt parts are thoſe on the ſeptum narium, on the whole lower portion of the internal nares, and on the conchae; and, if we make a ſmall hole in it at any of theſe places, and then blow through a pipe, we diſcover a very large cellular ſubſtance. In the ſinuſes it appears to be of a more ſlender texture.

Winſlow

Winſlow obſerves, that, on the ſide next the perioſteum and perichondrium, it is plentifully ſtored with ſmall glands, the excretory ducts of which are very long near the ſeptum narium, and their orifices are very viſible; and that, by applying a pipe to any of theſe orifices, the ducts may be blown up almoſt through their whole extent; but that, in order to this, the parts muſt firſt be very well cleaned and waſhed in lukewarm water. Sabatier gives ſomewhat of a different deſcription: He admits of mucous follicles; but ſays they are very different from thoſe which are properly called glands.

Sinus. The frontal, maxillary, and ſphenoidal ſinuſes open into the internal nares, but in different manners. The frontal ſinuſes open from above downward, anſwering to the infundibula of the os ethmoides deſcribed in the hiſtory of the ſkeleton. The ſphenoidales open forwards, oppoſite to the poſterior orifices of the nares; and the maxillares open a little higher, between the two conchae or oſſa ſpongioſa. Therefore the ſinus frontales diſcharge themſelves moſt readily when we ſtand or ſit; and the ſphenoidales, when the head is inclined forward.

The ſinus maxillares cannot be emptied wholly, or both, at the ſame time, in any one ſituation. Their openings, which in ſome ſubjects are ſingle, in others double, &c. lie exactly between the two oſſa ſpongioſa of the ſame ſide, about the middle of their depth; ſo that, when the head is held ſtraight, or inclined forward or backward, they can only be half emptied; but, when we lie on one ſide, the ſinus of the oppoſite ſide may be wholly emptied; the other remaining full.

It is proper here to obſerve the whole extent of the maxillary ſinus. Below, there is but a very thin partition between it and the dentes molares, the roots of which, in ſome ſubjects, perforate that ſeptum. Above, there is only a very thin tranſparent lamina between the orbit and the ſinus.

Backward, above the tuberoſity of the os maxillare, the ſides of the ſinus are very thin, eſpecially at the place which lies before the root of the apophyſes pterygoides. Inward, or toward the conchae narium, the bony part of the ſinus is likewiſe very thin.

Sacculus lacrymalis. The lacrymal ſacculus is an oblong membranous bag, into which the ſerous fluid is diſcharged from the eye, through the puncta lacrymalia already deſcribed, and from which the ſame fluid paſſes to the lower part of the internal nares. It is ſituated in a bony groove and canal, formed partly by the apophyſis naſalis of the os maxillare and os unguis, partly by the ſame os maxillare and lower part of the os unguis, and partly by this lower portion of the os unguis, and a ſmall ſuperior portion of the conchae narium inferior. This groove and canal are the bony lacrymal duct, about which beginners ſhould conſult what was ſaid in the deſcription of the ſkeleton.

With reſpect to the ſituation of this bony duct. It runs down for a little way obliquely backward, toward the lower and lateral part of the internal nares on each ſide, where its lower extremity opens on one ſide of the ſinus maxillaris under the os ſpongioſum inferius, nearly at the place from which a perpendicular line would fall in the interſtice between the ſecond and third dens molaris. The upper part of this duct is only an half-canal or groove; the lower is a complete canal, narrower than the former.

The ſacculus lacrymalis may be divided into a ſuperior or orbitary portion, and an inferior or naſal portion. The orbitary portion fills the whole bony groove, being ſituated immediately behind the middle tendon of the muſculus orbicularis. About one-fourth of its length is above this tendon, and the reſt below; the upper part is the lacrymal ſac properly ſo called; while the naſal portion, which lies in the bony canal of the noſe, being narrower and ſhorter than

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the former, is termed *lacrymal duct*; the one is merely a continuation of the other, without any valve, &c. between them.

The orbitary portion is diſpoſed at its upper extremity, much in the manner of an inteſtinum caecum, and at the lower extremity is ſomewhat narrower than the portio naſalis. Towards the internal angle of the eye, behind the tendon of the orbicular muſcle, it is perforated by a ſmall ſhort canal formed by the union of the lacrymal ducts.

The naſal portion becomes gradually larger towards its under end, and having reached the lower part of the bony duct under the inferior concha is perforated by a round opening, which at firſt ſight appears oblong.

If a tranſverſe line be drawn between the lower part of the noſe and os malae, and another line be drawn directly upward, oppoſite to the third dens molaris, or oppoſite to the ſecond and third, theſe two lines will interſect each other nearly at the lower extremity of this ſacculus.

Sometimes the upper extremity of this bag has been found divided into an anterior and poſterior part, by a kind of valvula connivens lying in the anterior portion, a little lower than the tendon of the muſculus orbicularis. The ſmall common canal of the two lacrymal ducts opens in the poſterior part of this ſacculus, and conſequently behind the valve.

The ſubſtance of this ſacculus is ſomething ſpongy or cellulous, and thickiſh, being ſtrongly united by its convex ſide to the perioſteum of the bony canal, which may be very diſtinctly ſhewn. Sabatier obſerves, that its ſubſtance is ſimilar to that of the membrana pituitaria, and that it is lined with the ſame kind of mucous within. Its uſe has been compared, by ſome late writers, to that of the bladder of urine, as was mentioned in the deſcription of the eye.

Ductus inciſorii. The ductus inciſorii, or naſo-palatini of Steno, are two canals which go from the bottom of the internal

ternal nares, croſs the arch of the palate, and open behind the firſt or largeſt dentes inciſorii. Their two orifices may be diſtinctly ſeen in the ſkeleton at the lower part of the naſal foſſae, on the anterior and lateral ſides of the criſtae maxillares; and we may likewiſe perceive their oblique paſſage through the maxillary bones; and laſtly, their inferior orifices, in a ſmall cavity or foſſula, called *foramen palatinum anterius*. In freſh ſubjects they are not ſo apparent, eſpecially in human ſubjects; but in ſheep and oxen they are eaſily diſcoverable.

Arteries and veins. The arteries of all theſe parts come chiefly from the external carotid. Thoſe of the external parts of the noſe are chiefly branches and rami of the arteria maxillaris externa or angularis, and of the temporalis; and the arteries of the internal parts are branches and ramifications of the maxillaris interna, and likewiſe ſmall branches from the ocular artery. The veins are, almoſt in the ſame manner, branches and ramifications of the external jugular; and they communicate with the orbitary ſinuſes, and, by that means, with the ſinus of the dura mater, and with the internal jugulars.

Nerves. The principal nerves belonging to the noſe are filaments of the nervi olfactorii, which run down through the holes of the tranſverſe lamina of the os ethmoides, and are diſtributed to the common membrane of the internal nares, eſpecially to its villous portions. The inner ramus of the orbitary or ophthalmic ſends a filament through the internal anterior orbitary hole into the cranium, which comes out again in company with one of the filaments of the olfactory nerve through the ethmoidal lamina.

This internal ramus advances afterwards toward the os unguis; and is diſtributed partly to the facculus lacrymalis, partly to the upper portion of the muſculus levator alae naſi, and of the integuments of the noſe. The ſuborbitary nerve, which

which is a branch of the maxillaris ſuperior, having paſſed through the inferior orbitary hole, ſends filaments to the lateral external parts of the noſe. Another ramus of the ſuperior maxillary nerve goes to the poſterior opening of the nares, being ſpent on the conchae and other internal parts of the noſe.

The outer part of the noſe is ſupplied by branches from the ſuperior maxillary nerve, or ſecond branch of the fifth pair, and by others from the portio dura of the ſeventh pair.

In animals which ſmell acutely, the parts of the noſe are remarkably large; but the formation of the human head into a roundiſh figure, has given to the organ of ſmelling only a ſmall extent of ſurface; but, to enlarge this the more, nature has made the internal parts of the noſe hollow, and variouſly complicated in a ſurpriſing manner.

§ 1. *Of Smelling.*

The taſting noxious food might in many inſtances be highly dangerous. We can by this ſenſe, independent of taſte, diſcover the noxious quality of aliments, eſpecially ſuch as are putrid, and conſequently peculiarly hurtful to the human frame; and at the ſame time that it directs us to avoid what is dangerous, it enables us to diſcern what is grateful and wholeſome. This uſe of ſmelling in chooſing food, is more obſervable in brutes than in men; yet men left to themſelves, and who are undebauched by a variety of ſcents, poſſeſs this ſagacious faculty in a very eminent degree. The powers and virtues of medicinal plants are hardly to be better known than by the ſimple teſtimony of taſting and ſmelling. Hence it is, that in all animals theſe organs are placed together; and hence the ſmelling is ſtronger, and the organs larger, in thoſe animals which are to ſeek their prey at a conſiderable diſtance,

tance, or to reject malignant plants from among thoſe that are fit for food.

The ſenſe of ſmelling is performed by means of a ſoft pulpy membrane, full of pores and ſmall veſſels, which lines the whole internal cavity of the noſtrils; it is thicker upon the ſeptum and principal convolutions, but thinner in the ſinuſes. Within this membrane are diſtributed veſſels and nerves which have been already deſcribed.

The nerves of the noſe, being almoſt naked, require a defence from the air, which is continually drawn through the noſtrils, and blown out again by reſpiration. Nature has therefore ſupplied this part, which is the organ of ſmelling, with a thick inſipid mucus, very fluid in its firſt ſeparation, but, by the air, condenſing into a thick, dry, and more conſiſtent cruſt. By this mucus the nerves are defended from drying and from pain. It is poured out from many ſmall arteries, and depoſited partly into numerous cylindrical ducts, and partly into round viſible cryptae or cells, ſcattered all over the noſtrils. It flows out all over the ſurface of the olfactory membrane, which is anointed with it on all ſides. This mucus is accumulated in the night time; but, in the day, it either flows ſpontaneouſly, or may be more powerfully expelled by blowing the noſe. By becoming dry and harſh, it irritates the very ſenſible nerves of the membrane, whence a ſneezing is excited for its removal. The ſinuſes of this part, which abound with mucus, are evacuated in the manner already deſcribed in page 121. The tears deſcend, by a channel proper to themſelves, into the cavity of the noſe, by which they moiſten and dilute the mucus.

The cartilages render the noſe moveable by its proper muſcles, ſo as to be raiſed and dilated by a muſcle common to the upper lip, and to be contracted together into a narrow compaſs by the proper depreſſor and compreſſor muſcle pulling down the ſeptum. Thus the prominent organ of ſmel-

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ling is adapted to the reception of ſcents; and it is dilated in proportion to the quantity of inhaled air, and again contracted, when the air is expelled in the ſame abundance.

The air, filled with the ſubtle and inviſible effluvia of bodies, conſiſting of their volatile, oily, and ſaline particles, is, by the powers of reſpiration, urged through the noſe, and applied to the almoſt naked, and conſtantly ſoft, olfactory nerves, in which a kind of feeling is excited, which we call *ſmelling*; and by this ſenſe we diſtinguiſh ſeveral kinds of oils and ſalts, by different ſcents or odours, which are difficultly reducible to claſſes, and difficultly recalled to memory. The odours, however, already eſtabliſhed, are ſufficient enough for our purpoſes. This ſenſe ſerves to admoniſh us of pernicious putrefaction; of violent acrimony; or of a mild and ſoapy quality in bodies. As ſalt, joined with an oil, is the object of taſte; and a volatile oil, added to ſalts, ſerves to excite ſmells, we may perceive the affinity of theſe two ſenſes, which affinity ſeemed to be the more neceſſary on account of theſe ſenſes mutually and jointly aſſiſting each other in performing their offices. Volatile particles are chiefly diſtinguiſhed by ſmell, and fixed ones by taſte; perhaps becauſe the thick mucous cuticle, ſpread over the tongue, intercepts the action of the more ſubtle ſaline effluvia from acting upon the taſte, which yet eaſily affect the ſofter and leſs covered nerves of the internal noſe. We are ignorant of the reaſon why ſome ſmells pleaſe, and others diſpleaſe; perhaps cuſtom may have much influence in this reſpect.

The power of odours is ſtrong and quick, becauſe minute particles of matter are immediately applied to naked nerves ſituated very near the brain: Hence the force of poiſonous vapours, and hence alſo the quality certain odours poſſeſs, of recovering people from faintings, or after drowning: Hence alſo that violent ſneezing which often ariſes from acrid particles, and a diarrhoea from the ſmell of ſome medicines; hence

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the power of particular antipathies: Hence alſo the pernicious effects of exceſſive ſneezing, more eſpecially in producing blindneſs, which may, in ſome meaſure, alſo be more eaſily brought on by the conſent of the nerves that are exceedingly numerous in theſe neighbouring organs. Among the various parts of the noſe, the ſeptum, and more eſpecially the os turbinatum, have a conſiderable ſhare in the organ of ſmelling, ſince theſe parts are multiplied in quick ſcented animals. In dogs, and other quadrupeds, they are prodigiouſly lengthened, and beautifully formed into ſpiral laminae; in fiſhes they are elegantly formed, like the teeth of a comb.

Sect. IV. The Ear.

The Ear in general. The ears are two; they are ſituated in the lateral parts of the head, and are the organs of hearing. Anatomiſts commonly divide or diſtinguiſh the ear into external and internal. By the external ear they mean all that lies without the external orifice of the meatus auditorus in the os temporis; by the internal ear, all that lies within the cavities of that bone, and alſo the parts that bear any relation thereto.

The greateſt part of the external ear conſiſts of a large cartilage, very artificially framed, which is the baſis of all the other parts of which this portion of the ear is compoſed. The internal ear conſiſts chiefly of ſeveral bony pieces, partly formed in the ſubſtance of the os temporis, and eſpecially in that portion of it called *apophyſis petroſa*; and partly ſeparated from, but contained in, a particular cavity of that bone.

The external ear. Two portions are diſtinguiſhed in the external ear; one large and ſolid, called *pinna*, which is the ſuperior, and by much the greater part; the other ſmall and ſoft, called the *lobe*, which makes the lower part. We may likewiſe conſider two ſides in the outward ear, one turned obliquely

obliquely forward, and irregularly concave; the other turned obliquely backward, and unequally convex; for all ears which have not been diſordered by binding the head too tight in childhood, are naturally bent forward.

The foreſide is divided into eminences and cavities. The eminences are four in number, called *helix*, *antihelix*, *tragus*, and *antitragus*. The helix is the large folded border or circumference of the great portion of the ear. The antihelix is the large oblong eminence, ſurrounded by the helix. The tragus is the ſmall anterior protuberance below the anterior extremity of the helix, which, in an advanced age, is covered with hairs. The antitragus is the poſterior tubercle, below the inferior extremity of the antihelix.

The cavities on the fore-ſide are four in number: The hollow of the helix; the depreſſion at the ſuperior extremity of the antihelix, called *foſſa navicularis*; the concha, or great double cavity that lies under the riſing termed *antihelix*, the upper bottom of which is diſtinguiſhed from the lower by a continuation of the helix in form of a tranſverſe criſta; and laſtly, the meatus of the external ear, ſituated at the lower part of the bottom of the concha.

The backſide of the external ear ſhews only one conſiderable eminence, which is a portion of the convex ſide of the concha, the other portion being hid by the adheſion of the ear to the os temporis. This adheſion hinders us likewiſe from ſeeing the hollow anſwering to the criſta, by which the cavity of the concha is divided.

The other parts of the external ear are ligaments, muſcles, integuments, ſebaceous and ceruminous glands, veſſels, and nerves.

The cartilage of the outward ear is nearly of the ſame extent and figure with the large ſolid portion already mentioned; but it is not of the ſame thickneſs, being covered by integuments on both ſides. In the lobe or ſoft lower portion

of the ear, this cartilage is wanting. On the backside, it shews all the eminences and cavities of the foreside in an opposite situation with respect to each other, except the fold of the great circumference; and it consists only of one piece from that circumference all the way to the meatus externus, except at the two extremities of the folded part of the helix, where there are two small separate portions connected to the great cartilage only by the integuments.

The cartilaginous portion of the external meatus auditorius does not make a complete circle, but rather a short tube, in one side of which there is a break, and which terminates in an oblique border fixed to the edge of the bony canal by several small inequalities; and, in consequence of this obliquity, the cartilaginous border terminates downward in a kind of apex or point. The lateral break in this cartilage is between the upper and back part of its circumference; and on each side thereof the cartilaginous edges are rounded. There are likewise two or three other small incisures in this circumference, which, in regard to the meatus, represent obliquely transverse fissures. The anterior fissure is in a manner quadrangular, neither are the intermediate parts always opposite to each other, for the uppermost is a little further from the os temporis than the posterior.

The external ear is fixed to the cranium, not only by the cartilaginous portion of the meatus already mentioned, but also by two ligaments, one anterior, the other posterior. The anterior ligament is fixed by one extremity to the root of the apophysis zygomatica of the os temporis, at the anterior and a little toward the superior part of the meatus osseus, close to the corner of the glenoid cavity; and by the other extremity, to the anterior and superior part of the cartilaginous meatus.

The posterior ligament is fixed by one end to the root of the mastoid apophysis; and by the other, to the posterior part

part of the convexity of the concha, ſo that it is oppoſite to the anterior ligament. There is likewiſe a kind of ſuperior ligament, which ſeems to be only a continuation of the aponeuroſis of the frontal and occipital muſcles.

Of the muſcles of the external ear, ſome go between the cartilages and the os temporis, others are confined to the cartilages alone. Both kinds vary in different ſubjects, and are ſometimes ſo very thin as to look more like ligaments than muſcles. The muſcles of the firſt kind are generally three, one ſuperior, one poſterior, and one anterior; and they are all very thin.

The ſmall muſcles which are confined to the cartilages, are only ſmall ſtrata of fibres found on both ſides of the cartilages. In many ſubjects they are of ſo pale a colour as not to look at all like muſcular fibres. Of this number are thoſe which Walſalva diſcovered in the different cavities on the backſide of the cartilage; and thoſe found by Santorini on the tragus, and along the convex part of the anterior portion of the helix. (*See* the Treatiſe on the Muſcles.)

The ſkin of the external ear is in general a continuation of that which covers the neighbouring parts of the temporal region. The ſkin on the foreſide of the ear is accompanied by a very ſmall quantity of cellular ſubſtance; and therefore we find all the eminences and cavities of that ſide diſtinctly marked upon it, as far as the bottom of the external meatus auditorius. In what has been ſaid of the ſkin, the epidermis is likewiſe comprehended.

The backſide is covered by the ſkin continued from the foreſide; but, as the folds are there very cloſe, it only paſſes over them, except that portion of the concha which ſurrounds the entry of the meatus auditorius, and which is joined to the os temporis by means of the cellular ſubſtance. The hollow of that common fold which lies between the antihelix

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and concha does not appear on the backſide; for, as it is filled with cellular ſubſtance, the ſkin paſſes over it.

The lobe of the ear, or that ſoft portion which lies under the tragus, antitragus, and meatus auditorius, is made up of nothing but ſkin and cellular ſubſtance. The meatus auditorius is partly bony and partly cartilaginous. The bony portion is the longeſt, and forms the bottom of the canal, as may be ſeen in the deſcription of the ſkeleton. The cartilaginous portion is the ſhorteſt; and, in adults, forms the external opening or orifice of the canal, as has been already ſaid.

Theſe two portions, joined endwiſe to each other, form a canal of a conſiderable length, of different wideneſs in its different parts, and a little contorted. It is lined on the inſide by the ſkin and cellular membrane, through its whole length; and thus theſe integuments make up for the breaks in the cartilaginous portions, and form a kind of cutaneous tube in the other portion. The cellular membrane is confounded with the perichondrium and perioſteum of the meatus.

The ſkin which covers both ſides of the cartilage contains a great number of ſmall glands, which continually diſcharge an oily whitiſh humour, collected chiefly near the adheſions of the ear to the head, and under the fold of the helix; and theſe glands are of the ſebaceous kind. The ſkin, which lines the meatus auditorius, contains another kind of glands, of a yellowiſh colour, and which may be plainly ſeen on the convex ſide of the cutaneous tube already mentioned.

Theſe glands are diſpoſed in ſuch a manner as to leave reticular ſpaces between them, and they penetrate a little way into the ſubſtance of the ſkin. They are called *glandulae ceruminoſae*, becauſe they diſcharge that matter which is named *cerumen* or the *wax* of the ear. They were firſt deſcribed by Steno, though ſome have named them after Duverney.

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The inner ſurface of the cutaneous tube is full of fine hairs, between which lie the orifices of the ceruminous glands. The firſt place in which we meet with theſe glands is on that part of the convex ſide of the cutaneous tube which ſupplies the breaks of the cartilaginous meatus.

The arteries of the external ear come anteriorly from the arteria temporalis, and poſteriorly from the occipitalis, both of which are branches of the external carotid. It is proper to obſerve here, that the occipital artery communicates with the vertebralis, and thereby with the internal carotid. The veins are rami of the jugularis externa, and the occipital vein; one of theſe rami communicates, not only with the vena vertebralis, but with the neighbouring lateral ſinus of the dura mater.

The portio dura of the auditory nerve having paſſed out of the cranium through the foramen ſtylo-maſtoideum, in the manner that ſhall be afterwards deſcribed, gives off a ramus, which runs up behind the ear, to the back ſide of which it ſends ſeveral filaments; and the trunk of this ramus ſends likewiſe filaments to the meatus and foreſide of the ear. The ſecond vertebral pair alſo ſends a ramus to the ear, the ramifications of which communicate with thoſe of the other ramus from the portio dura.

After having deſcribed the external parts of the ear, we next proceed to examine its internal bony parts. And here we ſhall conſider them at ſome length, as they are purpoſely omitted in the oſteological part of this work.

The bony part of the organ of hearing may be divided into four general parts: 1. The meatus auditorius externus; 2. The tympanum; 3. The labyrinth; 4. The meatus auditorius internus. It may likewiſe be divided into immoveable or containing parts, which take in all the four already mentioned; and moveable or contained parts, which are four

little

little bones lodged in the tympanum, called *incus*, *malleus*, *ſtapes*, and *os orbiculare* or *lenticulare*.

The external auditory paſſage begins by the external auditory hole, the edge of which is rough and prominent; but, backward toward the maſtoid proceſs, it appears very much ſloped. The paſſage itſelf is ſomewhat more than half an inch in length, running obliquely from behind forward in a curved direction. Its cavity is almoſt oval, but wider at each end than in the middle. It terminates inwardly by an even circular edge, lying in a plane very much inclined, the upper part of it being turned outward, and the inner part inward; ſo that the canal is longer on the lower than upper ſide. The circular edge is grooved quite round for the attachment of the membrana tympani.

In children, this bony canal is wanting, as well as the maſtoid proceſs; and the inner circular edge is a diſtinct ring, which, in an advanced age, unites entirely, and becomes one piece with the reſt. It is termed the *bony circle* in infants; and indeed it is very eaſily ſeparated from all the other parts.

It would ſeem, therefore, that the whole bony canal in adults is only a prolongation of the bony circle in children; becauſe, even in a more advanced age, the whole canal may without much difficulty be taken out. The circular groove lies between the maſtoid proceſs and the articular fiſſure mentioned in the deſcription of the other parts of the temporal bone.

Tympanum. The tympanum, or drum of the ear, is a cavity ſomewhat ſpherical, or rather hemiſpherical, the bottom of it being turned inward, and the mouth joined to the circular groove already mentioned.

The remarkable eminences are three: A large tuberoſity, lying in the very bottom of the tympanum, a little toward the back part; and a ſmall irregular pyramid, ſituated above the tuberoſity, and a little more backward; its apex is perforated

forated by a ſmall hole, and on one ſide of its baſis two ſmall bony filaments are often found in a parallel ſituation; and indeed it appears that they are ſeldom wanting, though their tender ſtructure expoſes them to be often broken. In the third eminence is a cavity ſituated at the upper and a little toward the anterior part of the bottom of the tympanum. This cavity is part of a half canal, which, in a natural ſtate, has one of the muſcles of the malleus lodged in it.

The principal cavities in the tympanum are, The opening of the maſtoid cells; the opening of the Euſtachian tube; the bony half canal; the feneſtra ovalis and rotunda; and to theſe may be added the ſmall hole in the pyramid.

The openings of the maſtoid cells are at the poſterior and upper part of the edge of the tympanum. The cells themſelves which end there are hollowed out in the ſubſtance of the maſtoid proceſs, being very irregular, and full of windings and turnings.

The opening of the Euſtachian tube is at the anterior and upper part of the edge of the tympanum. It runs from the tympanum towards the poſterior openings of the noſtrils and arch of the palate. Its bony portions, of which alone we here ſpeak, is hollowed out in the pars petroſa, and is afterwards lengthened out by the ſpinal proceſs of the os ſphenoides.

The maſtoid cells, and the Euſtachian tube, from their ſituation, may in ſome meaſure be conſidered as prolongations of the tympanum.

The bony half canal lies immediately above the Euſtachian tube, toward the upper ſide of the pars petroſa. In a natural ſtate, one of the muſcles of the malleus is lodged in it.

The feneſtra ovalis is a hole of communication between the tympanum and labyrinth. It lies immediately above the tuberoſity; the upper ſide of it being a little rounded, the lower a little flattened, and has its longeſt diameter from before

fore backwards. Toward the labyrinth, this opening has a little border quite round it, which renders it narrower at that place than any where elſe.

The feneſtra rotunda is ſomething leſs than the ovalis, and ſituated above it toward the lower and poſterior part of the large tuberoſity; the opening of it, which is the orifice of a particular duct in the labyrinth, lying obliquely backward and outward.

The hole in the apex of the pyramid is the orifice of a cavity, which may be named the *ſinus* of this pyramid.

Offıcula auditus. The tympanum contains ſeveral little bones, called *the bones of the ear.* They are generally four in number, denominated from ſomething to which they are thought to bear a reſemblance, viz. incus, malleus, ſtapes, and os orbiculare or lenticulare.

Incus. The incus, or anvil, reſembles, in ſome meaſure, one of the anterior dentes molares, with its roots at a great diſtance from each other. It may be divided into a body, and two branches or legs; one of the legs is long, the other ſhort. The body is turned forward, the ſhort leg backward, and the long leg downward.

The body of the incus is broader than it is thick. It has two eminences, and two cavities between them, much in the ſame manner as we ſee in the crown of the firſt crop of the dentes molares.

The ſhort leg is thick at its origin; and from thence decreaſing gradually, it ends in a point. It is ſituated horizontally, its point being turned backward, and joined to the edge of the maſtoid opening of the tympanum.

The long leg viewed through the external auditory paſſage appears to be ſituated vertically; but, if we look upon it either on the fore or back ſide, we ſee it is inclined, the extremity of it being turned much more inward than the root or origin. The point of the extremity is a little flatted, bent inward

inward like a hook, and ſometimes a little hollowed like a kind of ear-picker. By this we may diſtinguiſh the incus of one ear from that of the other, when out of their places: For, turning the ſhort leg backward, and the long leg downward, if the curvature of this long leg be toward the left hand, the bone belongs to the right ear; if toward the right, it belongs to the left ear.

Malleus. The malleus, or hammer, is a long bone with a large head, a ſmall neck, an handle, and two proceſſes; one in the neck, the other in the handle.

The top of the head is conſiderably rounded; and from thence it contracts all the way to the neck. Both head and neck are in an inclined ſituation; and the eminences and cavities of it anſwer to thoſe in the body of the incus. The handle is looked upon by ſome authors as one of the proceſſes of the malleus; and, in that caſe, it is the greateſt of the three. It forms an angle with the neck and head; near which it is ſomething broad and flat, and decreaſes gradually towards its extremity.

The proceſs of the handle, termed by others the *ſmall* or *ſhort proceſs* of the malleus, terminates in the angle already mentioned, being extended toward the neck, and lying in a ſtraight line with that ſide or border of the handle which is next it. The proceſs of the neck, called alſo *proceſſus gracilis*, is, in a natural ſtate, very long; but ſo ſlender, that it is very eaſily broken, eſpecially when dry; which is the reaſon why the true length of it was for a long time unknown. It ariſes from the neck, and ſometimes appears much longer than it really is, by the addition of a ſmall dried tendon ſticking to it.

When the malleus is in its true ſituation, the head and neck are turned upward and inward; the handle downward, paralled to the long leg of the incus, but more forward, the

proceſs of the handle upward and outward, near the ſuperior portion of the edge of the tympanum, near the centre of which is the extremity of the handle; and the proceſſus gracilis forward, reaching all the way to the articular fiſſure in the os temporis. It is eaſy, after what has been ſaid, to diſtinguiſh the malleus of the right ſide from that of the left.

Stapes. The ſtapes is a ſmall bone, very well denominated from the reſemblance it bears to a ſtirrup. It is divided into the head, legs, and baſis. The head is placed upon a ſhort flatted neck; the top of which is alſo ſometimes flat, ſometimes a little hollow.

The two legs, taken together, form an arch like that of a ſtirrup; in the concave ſide of which is a groove that runs through their whole length. One leg is longer, more bent, and a little broader than the other. The baſis reſembles that of a ſtirrup, both in its oval ſhape and union with the legs, but it is not perforated. Round its circumference next the legs is a little border, which makes that ſide of the baſis appear a little hollow. The other ſide is pretty ſmooth; and one half of the circumference is more curved than the other.

The ſubject being in an erect poſture, the ſtapes is to be conſidered as lying on its ſide, with the head turned outward near the extremity of the leg of the incus; the baſis, inward, being fixed in the feneſtra ovalis; the longeſt leg backward, the ſhorteſt forward; and both in the ſame plane. By this ſituation, it is eaſy to know the ſtapes belonging to each ear.

Os orbiculare. The os orbiculare, or lenticular *bone*, is the ſmalleſt bone in the body. It lies between the head of the ſtapes and extremity of the long leg of the incus, being articulated with each of theſe.

In dry bones, it is found very cloſely connected, ſometimes to the ſtapes, ſometimes to the incus; and might, in that ſtate,

ſtate, be eaſily miſtaken for an epiphyſis of either of theſe bones.

Theſe four little bones appear to have been unknown to the Greek anatomiſts. It is difficult to ſay with certainty who diſcovered them; but Veſalius is the firſt who has named the malleus and incus; Arantius or Sylvius, the os orbiculare; Ingratius is ſaid to have diſcovered the ſtapes.

Labyrinth. The labyrinth is divided into three parts; the anterior, middle, and poſterior. The middle portion is termed *veſtibulum*, the anterior *cochlea*, and the poſterior *labyrinth in particular;* which comprehends the three ſemicircular canals.

The cochlea lies forward and inward toward the extremity of the pars petroſa; the ſemicircular canals backward and outward toward the baſis of the proceſs; and the veſtibulum between the other two.

Veſtibulum. The veſtibulum is an irregular round cavity, leſs than the tympanum, and ſituated more inward, and a little more forward. Theſe two cavities are in a manner ſet back to back, with a common partition between them, perforated in the middle by the feneſtra ovalis, by which the cavities communicate with each other. The cavity of the veſtibulum is likewiſe perforated by ſeveral other holes; on the back ſide by the five orifices of the ſemicircular canals; on the lower part of the fore ſide by a hole, which is one of the paſſages of the cochlea; and, on the fore ſide, toward the internal meatus auditorius, oppoſite to the feneſtra ovalis, by a number of very ſmall holes, for the paſſage of the nerves; on the upper ſide there are only ſmall pores.

Semicircular canals. The ſemicircular canals are only three in number; one vertical, one oblique, and one horizontal; or by ſome they are called *vertical ſuperior*, *vertical poſterior*, and *horizontal* or *external.* The vertical canal is ſituated tranſverſely with reſpect to the pars petroſa, the convex ſide

of

of it being turned upward. The oblique canal lies farther back than the former, and runs parallel to the length of the proceſs, the convex ſide being turned backward, with one extremity upward, the other downward. The ſuperior extremity of this canal meets and loſes itſelf in the internal extremity of the former.

The curvature and extremities of the horizontal canal are almoſt on a level; the curvature lying obliquely backward, and the extremities forward, ending under thoſe of the vertical canal, but a little nearer each other, the inner being almoſt in the middle ſpace between the extremities of the oblique canal.

The horizontal canal is generally the leaſt of the three; the oblique is often, and the vertical ſometimes, the greateſt; and ſometimes theſe two are equal. All the three canals are larger than a ſemicircle, forming nearly three quarters; they are broader at the orifices than in the middle. Theſe orifices open into the back ſide of the veſtibulum, and are but five in number, becauſe two of them open into each other; ſo that, in the poſterior part of the veſtibulum, two appear toward the inſide, and three toward the outſide.

In children, the ſubſtance of theſe canals is compact, while that which ſurrounds them is ſpongy. Hence they may be eaſily ſeparated from the reſt of the pars petroſa. In adults, all the parts of the bone are ſo ſolid, that theſe canals appear only like paſſages formed in a piece of ivory. From this deſcription, it is eaſy to diſtinguiſh the right labyrinth from the left.

Cochlea. The cochlea is a ſort of ſpiral body with two ducts, formed in the anterior part of the pars petroſa, ſomewhat reſembling the ſhell of a ſnail. The parts to be diſtinguiſhed in it, in its true ſituation, are, the baſis; the apex; the ſpiral lamina, or half ſeptum, by which its cavity is divided into two half canals; the modiolus or ſpindle, round which

which the cochlea turns; and, laſtly, the orifices and union of the two ducts. The baſis is turned directly inward toward the internal foramen auditorium; the apex outward; and the axis of the modiolus is nearly horizontal; but, in all of them, allowance muſt be made for the obliquity of the pars petroſa in which they lie.

The baſis of the cochlea is gently hollowed; and, toward the middle, perforated by ſeveral ſmall holes. The modiolus is a kind of ſhort cone, with a very large baſis, which is the middle of the baſis of the cochlea. Through its whole length runs a double ſpinal groove, which, through a microſcope, ſhews a great number of pores. The cochlea makes about two turns and a half from the baſis to the apex; and the two half canals, being firmly united together through their whole courſe, form a half ſeptum, called *lamina ſpiralis*: which muſt not be confounded, as it often is, with the complete ſeptum in the recent ſubject. One edge of the lamina ſpiralis is ſtrongly joined to the modiolus, being thicker there than in any other place; whereas the other edge is terminated all round by a very thin border, lying in the middle cavity of the cochlea. In the natural ſtate, the other half of the ſeptum is membranous, and completes the partition between the two canals. The two half canals turn jointly about the modiolus; one being ſituated toward the baſis of the cochlea, the other toward the apex; for which reaſon we have always called one of them *internal*, the other *external*.

The ſpiral or volute of the cochlea begins at the lower part of the veſtibule; runs from thence forward to the top, then backward down to the bottom, afterward upward and forward; and ſo on from the baſis, which is turned inward, to the apex which is turned outward. From this deſcription, it is eaſy to know to which ear any cochlea belongs when we ſee it prepared: It likewiſe teaches us, that, in the right cochlea, the direction of the turnings is the ſame as in gar-

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den ſnails, and almoſt all the other common ſhells; but, in the left cochlea, the turnings are in a contrary direction. The two half canals communicate fully at the apex of the cochlea. Their ſeparate openings are towards the baſis, one of them being immediately into the lower part of the foreſide of the veſtibulum, the other into the feneſtra rotunda. Theſe two openings are ſeparated by a particular turning, which ſhall be afterwards deſcribed.

The *meatus auditorus internus*, is on the backſide of the pars petroſa, in ſome meaſure behind the veſtibule and baſis of the cochlea. It is a kind of blind hole, divided into two foſſulae, one large, the other ſmall. The large one lies loweſt, and ſerves for the portio mollis of the auditory nerve or ſeventh pair. The ſmall one is uppermoſt, and is the opening of a ſmall duct, through which the portio dura of the ſame nerve paſſes. The inferior foſſula is full of little holes, which, in the natural ſtate, are filled with nervous filaments of the portio mollis, that go to the veſtibule, to the ſemicircular canals, and to thoſe of the cochlea. It is this foſſula which forms the ſhallow cavity at the baſis of the ſpindle of the cochlea. The paſſage for the portio dura of the auditory nerve runs behind the tympanum, and its external orifice is termed *foramen ſtylomaſtoideum*. It begins by the ſmall foſſula, and pierces from within outward the upper part of the pars petroſa, making there an angle or curvature; from thence it is inclined backward behind the ſmall pyramid of the tympanum, and runs down to the foramen ſtylomaſtoideum, through which it goes out, and is diſtributed in the manner to be hereafter deſcribed. It communicates likewiſe by a hole with the ſinus of the pyramid, and lower down by another hole with the tympanum. At the upper part of the pars petroſa it is covered with a bony lamina, although ſometimes it has been found open above.

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The ſoft parts of the internal ear are chiefly the membrana tympani, the perioſteum of the tympanum, and of the officula auditus, labyrinth, and of all its cavities, the membrana maſtoidea interna, the muſcles of the officula, the parts which complete the formation of the Euſtachian tube, the arteries, veins, and nerves. We are, however, under a neceſſity of beginning by the tuba Euſtachiana, for two reaſons; firſt, becauſe the bony parts of that tube are but of very ſmall uſe for the knowledge of its whole ſtructure and compoſition; and, ſecondly, becauſe we are obliged to mention it in deſcribing the muſcles.

The *ductus auris palatinus*, or Euſtachian tube, as was obſerved in the deſcription of the ſkeleton, is a canal or duct which goes from the tympanum to the poſterior openings of the nares, or naſal foſſae, and toward the arch of the palate; it is dug in the apophyſis petroſa along the carotid canal, and it is lengthened out by the ſpinal apophyſis of the os ſphenoidale.

In its natural ſtate, this duct reaches from the cavity of the tympanum to the root or ſuperior part of the internal ala of the apophyſis pterygoides; and through this whole courſe it conſiſts of two portions, one entirely bony, and the other partly bony, partly cartilaginous, and partly membranous.

The bony portion lies through its whole length immediately above the fiſſure of the glenoid or articular cavity of the os temporis, and terminates at the meeting of the ſpinal apophyſis of the os ſphenoides with the pars petroſa of the os temporis.

The other or mixed portion reaches in the ſame direction from this place to the internal ala of the apophyſis pterygoides, or to the poſterior and outer edge of the nares. But to form a more exact idea of it, it will be proper to conſider it as divided into four parts, two ſuperior and two inferior.

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The two upper parts or quarters are bony; and of theſe the innermoſt is formed by the ſide of the apophyſis petroſa, the outermoſt by the ſide of the apophyſis ſpinalis of the os ſphenoides. Of the two inferior parts, the internal, or that next the os ſphenoides, is cartilaginous; and the external, or that next the pars petroſa, membranous.

The Euſtachian tube, thus formed, is very narrow next the ear, but grows gradually wider, eſpecially near the poſterior nares, where the inner cartilaginous ſide terminates by a prominent edge, and the outer ſide joins that of the neighbouring noſtril. The cavity of the tube is lined by a membrane like that of the internal nares, of which it appears to be a continuation; and on the prominent edge, this membrane is conſiderably increaſed in thickneſs, repreſenting a kind of half pad.

The ſituation of the two tubes is oblique, their poſterior extremities at the ears being at a greater diſtance than the anterior at the nares; and the convex ſides of the prominent edges are turned toward each other. The openings of the tubes are oval at this place, as is likewiſe their whole cavity, eſpecially that of the mixed portion.

The membrana tympani is a thin, tranſparent, flattiſh pellicle, the edge of which is round, and ſtrongly fixed in the orbicular groove which divides the bony meatus of the external ear from the tympanum or barrel. This membrane is very much ſtretched or very tenſe, and yet not perfectly flat: For on the ſide next the meatus externus it has a ſmall hollowneſs, which is pointed on the middle; and on the ſide next the tympanum it is gently convex, and alſo pointed in the middle.

This membrane is ſituated obliquely, the upper part of its circumference being turned outward, and the lower part inward, ſuitably to the direction of the bony groove already mentioned. It conſiſts of ſeveral very fine laminae, cloſely united

united together. The external lamina is in ſome meaſure a production of the ſkin and cuticula of the external meatus; for they may be pulled at the ſame time like the finger of a glove. The internal lamina is a continuation of the perioſteum of the tympanum; and, when the membrane has been macerated in water, each of theſe lamina may be ſubdivided into ſeveral others. In very young children, this membrane is covered on the outſide by a thick mucilaginous web.

The depreſſion in the middle of the membrana tympani, is cauſed by the adheſion of the malleus, the handle of which is cloſely joined to the inſide of the membrane, from the upper part of the circumference all the way to the centre, to which the end of the handle is fixed. This handle ſeems to lie in a very fine membranous duplicature, by means of which it is tied to the membrana tympani, and which ſerves it for a perioſteum. The malleus is accompanied with blood-veſſels, which run in a radiated manner from the centre to the circumference of the membrane; but theſe are beſt ſeen in the foetus.

The perioſteum of the tympanum, or barrel of the ear, produces that of the ſmall bones; and it may be made viſible by means of anatomical injections, which diſcover capillary veſſels very diſtinctly ramified on the ſurface of the officula. It is likewiſe continued over the two feneſtrae, and enters the Euſtachian tube, where it is loſt in the inner membrane of that duct.

The cellulae maſtoidae are very irregular cavities in the ſubſtance of the maſtoide apophyſis, which communicate with each other, and have a common opening towards the inſide, and a little above the poſterior edge of the orbicular groove. Theſe cells are lined by a fine membrane, which is partly a continuation of the perioſteum of the tympanum, and partly ſeems to be of a follicular ſtructure, like a kind of membrana

pituitaria. The maſtoid opening is oppoſite to the ſmall opening of the Euſtachian tube, but a little higher.

The ligaments of the officula may be looked upon as continuations of the perioſteum. The incus is tied by a ſtrong ſhort ligament, fixed in the point of the ſhort leg to the edge of the maſtoid opening. Between the incus and malleus we find a ſmall thin cartilage. The malleus is connected through the whole length of its handle to the inſide of the membrana tympani, in the manner already ſaid.

The malleus has two little muſcles, one anterior, and one internal; and the ſtapes has one muſcle. *See* Innes on the Muſcles.

The internal muſcle of the malleus, called *tenſor tympani*, is very fleſhy and diſtinct. It lies along the inside of the Euſtachian tube, and is inſerted in the neck of the malleus, above the ſmall apophyſis, advancing likewiſe as far as the handle. Veſalius firſt obſerved, and afterwards Euſtachius more particularly deſcribed, this muſcle.

The anterior muſcle of the malleus, called, from its uſe, *laxator tympani*, is ſaid by ſome to be fleſhy, long, and thin. It runs along the outſide of the Euſtachian tube, to which it adheres very cloſely through its whole length, and is inſerted in the long thin apophyſis of the malleus. It is partly accompanied by a nerve, which forms what is called the *chorda tympani*, as we ſhall ſee hereafter. Haller denies the exiſtence of muſcular fibres in this ſubſtance. Sabatier deſcribes it, but doubts if it be really muſcular. Caecilius Folius is ſaid to have been the diſcoverer.

A third muſcle has by ſome been deſcribed under the name of *external* or *ſuperior muſcle of the malleus*; but this is much leſs diſtinct than thoſe already mentioned. It is ſaid to ariſe from the internal ſuperior and poſterior part of the meatus externus, and to be fixed by a ſmall tendon to the neck of the malleus. Neither Haller nor Sabatier have been

able

able to diſcover muſcular fibres in it. Caſſerius firſt deſcribed it.

The muſcle of the ſtapes is ſhort and thick, and lies concealed within the ſmall bony pyramid at the bottom of the tympanum. It runs forward to be inſerted in the neck of the ſtapes, on the ſide of the longeſt and moſt crooked leg of that bone.

The three parts of the labyrinth, that is, the veſtibulum, ſemicircular canals, and cochlea, are lined by a fine perioſteum, which is continued over all the ſides of their cavities, and ſhuts the two feneſtrae of the tympanum. Upon this fine perioſteum the veſſels and nerves are diſperſed.

The ſemicircular canals are ſimply lined by a perioſteum adhering to their inner ſurfaces without any particular membranous bands. The two half canals of the cochlea are lined in this manner; the perioſteum of the two ſides of the bony ſpiral lamina advances beyond the edge of that lamina, and forms a membranous duplicature, which, extending to the oppoſite ſide, completes the ſpiral ſeptum.

The ſeptum ſeparates the two half canals from the baſis to the apex; but there it leaves a little opening, by which the ſmall extremities of the half canals communicate with each other. The large extremity of the external half canal ends by an oblique turn in the feneſtra rotunda, which is ſhut by a continuation of the perioſteum of that canal. The large extremity of the other half canal opens into the veſtibulum; and theſe two extremities are entirely ſeparated by a continuation of the perioſteum.

The whole internal cavity of the labyrinth is filled with a watery fluid ſecreted from the veſſels, which are diſperſed upon the perioſteum. This fluid tranſmits to the nerves the vibrations it receives from the membrane ſituated between the tympanum and labyrinth.

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The ſuperfluous part of this fluid is ſuppoſed to paſs off through two ſmall canals called the *aqueducts of Cotunnius*, from the diſcoverer, an ingenious phyſician at Naples. One of theſe ducts is ſent off from the cochlea, at the under part of the ſcala tympani, near the feneſtra rotunda; it terminates by a wide triangular opening within the cranium, under the meatus internus. The beginning of this duct was known to Duverney, Caſſebohm, and Morgagni; but they conſidered it as a paſſage for an artery and a vein. It is lined internally with the dura mater, which is connected with the perioſteum of the cochlea. The other duct goes off under the termination of the common canal in the veſtibule. The orifice of this was firſt diſcovered by Caſſebohm, and afterwards by Morgagni, who has deſcribed it; but is unacquainted with its uſe. From this place the duct aſcends, and terminates by a triangular opening between the layers of the dura mater, at the back part of the pars petroſa, under the middle of its upper edge. It is alſo lined by a production of the dura mater, which may be traced to the veſtibule. For a full account of theſe ducts, ſee an excellent Diſſertation by Dr Meckel of Berlin.

All the perioſteum of the internal ear, eſpecially that of the officula and tympanum, is in children no more than a mucilage; and in them likewiſe the membrana tympani is thick, opaque, and covered with a whitiſh ſlimy matter.

Through the whole extent of the perioſteum of the internal ear, eſpecially on that of the officula, ſemicircular canals, and half-canals of the cochlea, we diſcover a vaſt number of blood-veſſels, not only by anatomical injections, but in inflammations, and even without the help of a microſcope. The arteries come partly from the internal and external carotids, and partly from the arteria baſilaris, which is a continuation of the vertebralis, the ſmall capillary ramifications of which may be obſerved to accompany the auditory nerve through the

the internal foramen auditorium. Two veins carry the principal part of the blood from the labyrinth; one goes off from the cochlea, near its aqueduct, and ends in the lateral ſinus; the other lies near the aqueduct of the veſtibule, and carries the blood from that cavity, and from the ſemicircular canals, into the beginning of the internal jugular vein, by a triangular opening.

The portio mollis of the auditory nerve ends, by its trunk, at the great foſſula of the internal auditory hole, from whence the filaments paſs through ſeveral ſmall holes in the baſis of the cochlea, to be diſtributed through the cochlea, the veſtibule, and the ſemicircular canals. *See* Monro on the Nervous Syſtem, Tab. XXIX. XXX. XXXI.

The portio dura runs firſt of all into the ſmall foſſula of the foramen auditorium internum, then paſſes through the whole bony duct, called *aquaeductus Fallopii*, and comes out again through the ſtylo-maſtoid hole of the os temporis. In this courſe it communicates with the dura mater on the upper or anterior ſide of the apophyſis petroſa, at the place where the bony duct is interrupted.

Having reached behind the ſmall pyramid in the bottom of the tympanum, this nerve ſends a ſmall filament to the muſcle of the ſtapes; and, a little before it goes out by the ſtylo-maſtoid hole, it gives off another more conſiderable filament, which enters the tympanum from behind forward, paſſes between the long leg of the incus and handle of the malleus, and afterwards runs croſs the whole breadth of the tympanum a little obliquely, and goes out at the ſame place at which the tendon of the anterior muſcle of the malleus enters.

This ſmall nerve is generally called *chorda tympani*, becauſe in its paſſage through the tympanum it has been compared to the cord of a drum. Having left the cavity of the internal ear, it advances towards one ſide of the baſis of the tongue, where

where having joined the nervus lingualis of the fifth pair, it is conſidered as a kind of recurrent; but the remaining part of its courſe muſt be referred to the deſcription of the tongue.

The portio dura of the auditory nerve having paſſed through the foramen ſtylo-maſtoideum, is diſtributed in the manner to be afterwards mentioned in the deſcription of the nerves; and we ought very carefully to obſerve its different communications with the branches and rami of the nerves of the fifth pair, with the ſympatheticus medius or eighth pair, with the ſecond pair of cervical nerves, and with the nervi ſub-occipitales, or tenth pair of the medulla oblongata, &c.

Hearing. As the ſenſe of hearing perceives the elaſtic tremors or impulſions of the air, ſo we obſerve the ſenſitive organ of the ear to be compoſed in a different manner from that of any of the other ſenſes. It conſiſts, for the moſt part, either of hard bones, or elaſtic cartilages and membranes, which are the moſt exquiſitely enabled to receive and communicate the neceſſary tremors.

As we have already deſcribed the ſeveral parts of this complicated organ, we ſhall proceed to its phyſiology.

The ſonorous waves of the air flow into the external ear, which, from principles of mechanics, it muſt of courſe collect together. Elaſtic air receives, and is the principal means of transferring ſonorous tremors; for ſound is increaſed in condenſed air, and is loſt in vacuo. Other bodies, however, have the property of conveying ſound; and Dr Monro has ſhewn, in his Phyſiology of Fiſhes, that water conveys ſound nearly as quickly as the atmoſphere. The transferring medium receives theſe tremors, either from ſome body ſtriking againſt it, or from the medium itſelf colliding againſt another body, or laſtly, from the colliſion of two bodies againſt each other. Every particle of the body which produces ſound, ought to tremble or vibrate in ſuch a manner as alternately

nately to elevate and depreſs its plain ſurface into the form of arches or curves, ſo as to produce the above mentioned ſonorous waves. Theſe oſcillations or impulſions of the air are required to ſucceed each other with a certain velocity; and, in order to render them audible, they muſt not be fewer than 30 in a ſecond.

Acute ſounds are, in general, produced from bodies that are hard, brittle, and violently ſhook or ſtruck; but grave ſounds from bodies of a contrary nature. Thoſe ſounds, in general, are called *acute*, which are produced from more numerous tremors in an equal time; and thoſe *obtuſe* or *grave*, which are produced from few tremors. As to any medium between acute and grave ſounds, there is none but what is arbitrary. Cords, or other bodies, that yield the ſame number of vibrations in a given time, are ſaid to be in *uniſon*; if one cord vibrates twice while another vibrates once, it produces an *octave*; if one vibrates thrice while the other vibrates twice, it produces a *fifth*; and other proportions between the number of vibrations produce different tones or notes. Shorter cords produce ſharper tones; and the contrary; and the tenſions being the ſame, the ſharpneſs of the tones will be inverſely proportional to their lengths. The lengths being the ſame, the ſharpneſs will be in the ſubduplicate proportion of the ſtretching force. Experiments to this purpoſe are very eaſily made with a monochord, or a ſeries of cords ſtretched with weights.

The ſound thus produced, whether acute or grave, ſtrong or weak, is carried through the air with a velocity equal to about 1142 feet in a ſecond, or above 13 miles in a minute; and that with an uniform velocity, without abating in the larger diſtances; but a contrary wind, cauſing the vibrations to extend more ſlowly, retards the progreſſion of ſound about one-twelfth of its velocity. Denſity and dryneſs of the air increaſe the ſound, as a rarefaction and moiſture of the air

leſſen

leſſen it. Hence, in ſummer time, ſounds move ſwifter; and in Guinea it has been obſerved to paſs at the rate of 1170 feet in a ſecond.

The ſound, thus every way extended, meets with certain particles in all adjacent bodies, even in water and mercury, to which it communicates ſimilar tremors or vibrations; not only to ſuch as are in uniſon with the original tone, but alſo to others. From hence it is, that every ſound which we hear is a mixture of the original tone, produced by the trembling body, in conjunction with ſecondary tones generated from the elaſtic tremors of the ſurrounding bodies. The ſtrength of ſound is increaſed, if one audible or primary tone follows the other ſo cloſely, that their ſucceſſion cannot be diſtinguiſhed by the ear; but, if they follow each other ſo ſlowly as to be diſtinguiſhable by the ear, they produce an echo; but, to produce this, requires an interval of ſix thirds of time, or the diſtance of 55 feet between the echoing body and the ear.

The ſonorous waves of the elaſtic air, being driven into the cartilaginous funnel of our ear, are repelled and collected together, by alternate reflections from its elaſtic ſides, into the cavity of the concha, whence they proceed through the auditory paſſage; where their force is increaſed, (in proportion to the difference between the ſurface of the outer ear and the area of the paſſage), by being contracted into ſo narrow a compaſs. They are likewiſe increaſed by new ſounds from the percuſſion of the elaſtic cartilages and hard bones, which mix imperceptibly with the primitive ſounds.

The bottom or end of the auditory paſſage is terminated internally by the *membrana tympani*; which Dr Haller ſays is not naturally perforated, as far as he has been able to diſcover; and that the tranſmiſſion of tobacco-ſmoke from the mouth through the ear is fabulous. Authors in general agree with him now in the former of theſe opinions; but that an accidental

accidental opening has ſometimes happened, and that the ſmoke of tobacco has been blown through it during life, is certain. Upon the ſurface of this membrane, and more eſpecially upon its conical cavity pointing inward, the ſonorous waves ſtrike, after they have received their laſt reflections from the auditory paſſage, by which the elaſtic fabric of this membrane is forced into oſcillation.

The membrane is ſtretched over the *tympanum*, containing the little bones to which the ſmall muſcles of the internal ear are fixed. By means of the tenſor of the malleus, the membrane of the tympanum is the better diſpoſed to hear weak ſounds; and the other muſcle ſerves to moderate thoſe that are too violent, by drawing the malleus from the incus; by which means the propagation of the ſonorous tremors is interrupted. If the membrane of the tympanum be broke, or the bones of hearing diſlocated, the perſon becomes at firſt hard of hearing, and afterwards, ſays Dr Haller, perfectly deaf. There have been inſtances, however, where the membrana tympani has been partly deſtroyed, and yet the perſon has retained the ſenſe of hearing, though leſs diſtinctly than before.

The malleus returns the tremors impreſſed upon the membrane of the tympanum to the incus, which ſends it inwards to the next bones.

The *ſtapes*, aptly enough ſo called from its figure, lies inclined, and is covered by its own muſcle, which ſeems to draw the ſtapes, that it may lie higher up, under the back part of the feneſtra ovalis, and paſs out of it before. Thus the nervous pulp of the veſtibulum is preſſed by the baſis of the ſtapes, and by the air of the tympanum; and the *Euſtachian tube*, by the action of the circumjacent muſcles, may be compreſſed and cloſed, and probably a little relaxed and opened again, by the circumflex muſcle of the moveable palate. By this canal the inſpired air enters into the tympa-

num, to be changed or renewed; and it alſo ſerves to convey the mucus that covers the little bones and the tympanum: Nor is it at all improbable that the air enters by this tube, to ſupport the tympanum when it is preſſed inward by the more violent ſounds; for ſounds themſelves, received into the mouth, are this way conveyed to the organ of hearing. In inſpiration, the air preſſes the membrane of the tympanum outward; and from thence proceeds that claſhing or whiſpering noiſe, by which the hearing is obſcured, in yawning; for then the air entering more abundantly through the cavity of the tube, to the tympanum, reſiſts the tremors of the external air.

With reſpect to the nerve which is diſtributed through the veſtibulum and ſemicircular canals, there is no doubt but it is ſtruck by the tremors of the external air, propagated to the ſtapes; from whence the tremors immediately paſs through the feneſtra ovalis, to preſs upon the naked pulp of the nerve; and it is probable that the ſpiral plate of the cochlea, ſpread full of nerves, is agitated with tremors from the oſcillations of the membrane of the tympanum, by which the air in the cavity of the tympanum is agitated, ſo as to preſs the membrane of the feneſtra rotunda, which again agitates the air contained in the cochlea.

The preceding conjecture is plauſible; ſince the ſpiral plates form a triangle, with a very acute vertex, on whoſe ſurface it is poſſible that a number of tranſverſe nervous cords may be ſtretched; and theſe cords, being of different lengths, will be in uniſon with a variety of tones, ſo as to tremble iſochronally with them; namely, the longeſt cords in the baſis of the cochlea with grave ſounds; and the ſhorteſt cords nearer the tip or apex, with ſharper ſounds. Whether are ſounds perceived in the middle ſemicircular canals, ſince theſe alone are found in all claſſes of animals? Are they detained in theſe canals, in the cochlea, and by the membrane

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ſuſpended through the veſtibulum? This ſeems probably the caſe.

From what has been ſaid, it appears that the elaſtic waves or tremors of the air come through the outer ear and auditory paſſage, to the membrane of the tympanum, which being injured, and not repaired, the hearing is in a great meaſure deſtroyed. This ſeems to be ſtretched, for hearing weak ſounds, by the muſcles of the malleus. From this membrane the ſound is conveyed through the ſmall bones to the veſtibulum; for, theſe bones being deſtroyed, the hearing is again aboliſhed. The bony ſides of the veſtibulum, by their tremulation, agitate the ſmall quantity of aqueous fluid ſurrounding the nervous pulp. It ſeems to be ſtruck by the nervous pulp ſuſpended in the veſtibulum, and that tremor ſeem to be continued through the continuous pulp of the cochlea and ſemicircular canals. Of more than this we are not certain; but, by undoubted experiments, tremors, and even elaſtic ſounds, communicate themſelves by the internal Euſtachian tube, and through all the bones of the ſkull ſo as to impreſs their force upon the auditory nerve.

The diſtinction of ſounds proceeds from the celerity of the tremors excited in the hearing nerve, according as they ſucceed each other more ſwiftly or ſlowly. It is not neceſſary that the mind ſhould number them; it is ſufficient that ſhe perceive their numbers to be different, and that this difference excites a variation in the thoughts and ideas thence ariſing. Does the harmony or agreeableneſs of ſounds ariſe from the number of parts ſounding together in uniſon? and does the mind number the degrees or conſonance, ſo as to pleaſe herſelf in a majority of them? Theſe are queſtions denied by the moſt expert muſicians, who make it appear that there is an agreeableneſs, and that very conſiderable, in ſounds approaching the leaſt to a conſonance, and which are in a proportion very difficult to determine. Why

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do ſounds often become too ſharp for the ear? Becauſe our auditory nerves ſeem to be ſo ſtrained upon the ſpiral plates, as to be in danger of breaking. Thus, drinking glaſſes are broken by ſharp ſounds; and the hearing is ſometimes almoſt loſt for a while by the violently ſhrill whiſtlings of the inhabitants of the Canary iſlands.

Sect. V. The Mouth, &c.

Introduction. The word *mouth* may have two ſignifications: For, firſt, it means the tranſverſe ſlit between the noſe and chin, formed by the lips; and, ſecondly, it expreſſes the internal cavity, of which this tranſverſe ſlit is the external opening. For this reaſon, the mouth may be diſtinguiſhed into external and internal; and the parts of which it conſiſts may likewiſe come under the ſame two general heads. The bony parts are the oſſa maxillaria, oſſa palati, maxilla inferior, and the teeth: To theſe we may add the os hyoides, and the upper vertebrae of the neck.

The external parts of the mouth are, the two lips, one upper, the other under; the borders or red parts of the lips; the corners or commiſſures of the lips; the foſſula of the upper lip, the baſis of the under lip; the chin; the baſis of the chin; the ſkin; the beard; and even the cheeks, as being the lateral parts of the mouth in general, and of the lips in particular.

The internal parts of the mouth are, the gums, palate, ſeptum palati, uvula, amygdalae, the tongue, the membrane which lines the whole cavity of the mouth, the ſalival ducts and glands, and the bottom of the mouth. We might likewiſe reckon, among the internal parts of the mouth, all the muſcles that have any relation to it, as thoſe of the lips, of the tongue, of the uvula, of the ſeptum palati, &c; and to theſe

theſe might be added the muſcles of the lower jaw, and of the os hyoides.

§ 1. *The Cheeks, Lips, and Gums.*

THE cheeks and lips form the ſides and entry of the cavity of the mouth. They are formed in general by the connection of ſeveral fleſhy portions of different breadths, fixed round the convex ſides of the two jaws, covered on the outſide with the ſkin and fat, and lined on the inſide by a glandular membrane. Beſides all this, the lips ſeem likewiſe to have a fat ſoft ſpongy ſubſtance in their compoſition, which ſwells and ſubſides on certain occaſions, independently of the action of the muſcles belonging to them.

The ſubſtance which forms the red border of the lips is very different from the reſt of the ſkin, being a collection of very fine, long, villous papillae, cloſely connected together, and covered by a fine membrane, which ſeems to be both a continuation of the epidermis, and of that pellicle which covers the glandular membrane of the cavity of the mouth. This ſubſtance is extremely ſenſible, and very painful when the outer membrane is by any accident deſtroyed. The internal membrane of the upper lip forms a ſmall middle fraenum above the firſt dentes inciſorii.

The gums are that reddiſh ſubſtance which covers the two ſides of the whole alveolary border of both jaws, inſinuates itſelf between all the teeth, ſurrounds the collar of each tooth in particular, and adheres very ſtrongly to them. Therefore the outer and inner gums are continuous, and both together form juſt as many openings as there are teeth.

The ſubſtance of the gums is of a very ſingular ſtructure, reſembling, in ſome meaſure, the texture of a hat, ſuppoſed to be very compact and elaſtic. It is not immediately fixed to the bones of the jaws, but by the intervention of the periofteum

oſteum, with which it is perfectly united; and it is covered by a fine ſtrong even membrane, which ſticks very cloſe to the ſubſtance of the gums; and ſeems to be a continuation of that thin membrane which goes to the lips and cheeks, and of that which goes to the tongue.

The arteries which go to the lips, cheeks, and gums, are ramifications of the external carotid, and chiefly of thoſe branches called *maxillares externae et internae*. The veins are ramifications of the external jugular.

The nerves of theſe parts come from the maxillaris ſuperior and inferior, which are branches of the fifth pair; and alſo from the portio dura of the auditory nerve, or ſympatheticus minimus; the ramifications of which are ſpread in great numbers on all theſe parts, and communicate in a ſingular manner with the nerves of the fifth pair in ſeveral places, as may be ſeen in the Deſcription of the Nerves.

The muſcles of the lips are commonly divided into common and proper. The common muſcles are thoſe which end at the angles or commiſſures of the two lips; and thoſe are proper which are fixed in one lip only; which are again ſubdivided into the proper muſcles of the upper lip, and proper muſcles of the under lip. All theſe muſcles have particular names; ſome of them are taken from the peculiar conformation of the muſcles, ſome from the inſertions or ſituation, and ſome from the uſes attributed to them, as has been already deſcribed.

The muſcles may be enumerated in the following order: Levator anguli oris; levator labii ſuperioris alaeque naſi; depreſſor labii ſuperioris alaeque naſi; depreſſor anguli oris; depreſſor labii inferioris; levator labii inferioris; buccinator; zygomaticus major, zygomaticus minor, orbicularis oris. *See* Vol. I.

The common muſcles of the lips either draw both corners of the mouth at once, or only one at a time, according to the

the different direction of their fibres. The proper muſcles pull the different parts of the lips in which they are inſerted. The buccinators, in particular, may ſerve to move the food in maſtication. An entire treatiſe might be written on the almoſt innumerable combinations of the different motions of all theſe muſcles, according to the different paſſions, and according to the different poſtures in which a man may put his face. None are more affecting than thoſe produced by the cutanei alone, eſpecially in weeping. By their inſertions in the bone of the lower jaw, they draw up the lower part of the integuments of the neck, and thoſe of the breaſt next to theſe; for they cannot move the jaw. In old people, and in thoſe who are very much emaciated, theſe muſcles may be perceived by the eye, under the chin, and on the neck.

§ 2. *The Palate, Uvula, &c.*

The palate is that arch or cavity of the mouth, ſurrounded anteriorly by the alveolary edge and teeth of the upper jaw, and reaching from thence to the great opening of the pharynx. The arch is partly ſolid and immoveable, and partly ſoft and moveable. The ſolid portion is that which is bounded by the teeth, being formed by the two oſſa maxillaria and two oſſa palati. The ſoft portion lies behind the other, and runs backward like a veil fixed to the edge of the oſſa palati, being formed partly by the common membrane of the whole arch, and partly by ſeveral muſcular faſciculi, &c.

The membrane that covers all this cavity, is continued with the membrane of the nares, upon the inner ſurface of the pharynx. It is very thick ſet with ſmall glands, known under the name of *palatine*, the orifices of which are not ſo ſenſible as in the pharynx, and eſpecially in the rugae of its ſuperior portion, where Mr Heiſter obſerved a conſiderable orifice, and a canal proportioned to that orifice, which he could eaſi-

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ly inflat with air. Small ducts of the same kind with what has now been mentioned, may be supposed to lie along the middle line or raphe of the arch of the palate, and along the alveolary edge, because of some small tubercles or points which appear there.

This membrane, together with that of the posterior nares, forms, by an uninterrupted continuation, the anterior and posterior surface of the soft portion of the palate, or velum palati, so that the muscular fasciculi of this portion lie in the duplicature of a glandular membrane.

The velum or valvula palati, terminates below by a loose floating edge, representing an arch situated transversely above the basis or root of the tongue. The highest portion or top of this arch sustains a small, soft, and irregularly conical glandular body, fixed by its basis to the arch, and its apex, which hangs down without adhering to any thing, is called *uvula*.

On each side of the uvula there are two muscular half arches, called *columnae septi palati*. They are all joined to the uvula by their upper extremities, and disposed in such a manner as that the lower extremities of the two which lie on the same side, are at a little distance from each other, and so as that one half arch is anterior, the other posterior, an oblong triangular space being left between them, the apex of which is turned toward the basis of the uvula.

The two half arches on one side, by joining the like half arches on the other side, form the entire arch of the edge of the septum. The posterior half arches run by their upper extremities, more directly toward the uvula than the anterior. The anterior half arches have a continuation with the sides of the basis of the tongue, and the posterior with the sides of the pharynx. At the lower part of the space left between the lateral half arches on the same side, two glands are situated, termed *amygdalae*, which shall de described hereafter, together

together with the glandular ſtructure of the uvula, among the other glands of the mouth.

The half arches are chiefly made up of ſeveral flat fleſhy portions, almoſt in the ſame manner with the body of the ſeptum. The membrane which covers them is thinner than the other parts of it towards the palate, pharynx, and tongue. Each portion is a diſtinct muſcle, the greateſt part of which terminates by one extremity in the ſubſtance of the ſeptum, and of the half arches, and by the other extremity in parts different from theſe.

As anatomiſts uſed formerly to aſcribe all theſe muſcles, as far as they knew them, to the uvula, without any regard to the ſeptum, they termed them in general either *ptery-ſtaphylini*, or *peri-ſtaphylini*. The laſt part of theſe two compound words expreſſes the uvula: The firſt part of the firſt word is an abridgement of ptery-goides, and expreſſes the inſertion of theſe muſcles; but the firſt part of the ſecond word ſignifies no more than round, or about, &c.

We might make uſe of the term *peri-ſtaphylinus* as a general denomination for the muſcles belonging to the ſeptum, and then add the other terms, of which theſe names have been made up by modern writers. But the reader will find it more agreeable to uſe the names expreſſed in the treatiſe on the muſcles already deſcribed.

Of the muſcles of the palate we have found the conſtrictores iſthmi, faucium, palato phyryngei, tenſores palati, levatores palati, and azygos uvulae.

The ſeptum palati ſerves to conduct the lacrymal lymph, and that which is continually collected on the arch of the palate, into the pharynx. It ſerves for a valve to hinder what we ſwallow, and eſpecially what we drink, from returning by the noſe.

§ 3. *The Tongue.*

THE tongue is a ſoft fleſhy body, which fills all that part of the cavity of the mouth that is ſurrounded by the alveolary border and teeth of the lower jaw, and extends ſtill farther back. All this ſpace is therefore in a manner the mould and meaſure of the length and breadth of the tongue, as well as of its thickneſs and figure.

The tongue is divided into the baſis and point; the upper and under ſides; and the lateral portions or edges. The baſis is the poſterior and thickeſt part; the point, the anterior and thinneſt part. The upper ſide is not quite flat, but a little convex, and divided into two lateral halves, by a ſhallow depreſſed line, called *linea linguae mediana*. The edges are thinner than the other parts, and a little rounded, as well as the point. The lower ſide reaches only from the middle of the tongue to the point.

The tongue is principally compoſed of very ſoft fleſhy fibres, intermixed with a particular medullary ſubſtance, and diſpoſed in various manners. Many of theſe fibres are confined to the tongue without going any farther; the reſt form ſeparate muſcles, which go out from it in different ways, and are inſerted in other parts. All the upper ſide of the tongue is covered by a thick membrane of a papillary texture, upon which lies another very fine membrane like a kind of epidermis, which is likewiſe continued over the lower ſide, but without papillae. Under the epidermis, on the ſurface of the tongue, we find the corpus mucoſum thicker but more moiſt than in other parts of the body. This diſpoſition ſeems neceſſary to protect the tender papillae, which are the organs of taſte. In brute animals, a perforated mucous net-work receive the papillae, which are in a manner wrapped

ped up in capſules of this mucous body covered with the cuticle.

Three ſorts of papillae may be diſtinguiſhed in the upper ſide of the tongue; capitatae, ſemi-lenticulares, and villoſae. Thoſe of the firſt kind are the largeſt, and are of a lenticular form, having round heads with ſhort ſtems. They lie on the baſis of the tongue in ſmall ſuperficial foſſulae.

They have a ſmall depreſſion in the middle of their upper or convex ſide, which opens into a mucous follicle. They occupy the whole ſurface of the baſis of the tongue; and they are ſituated near each other in ſuch a manner as that the moſt anterior form an angle. They are glandular papillae, or ſmall ſalival or mucilaginous glands, of the ſame kind with thoſe that are to be deſcribed hereafter.

We commonly obſerve about the middle of this part of the tongue a particular hole of different depths, the inner ſurface of which is entirely glandular, and filled with ſmall papillae like thoſe of the firſt kind. It is called *foramen caecum Morgagni*, as being firſt deſcribed by that author. It is nothing elſe than the meeting of excretory ducts of glands ſituated in the tongue, and which throw out a thick ſaliva.

The papillae of the ſecond kind, or ſemi-lenticulares, are ſmall orbicular eminences, only a little convex, their circular edges not being ſeparate from the ſurface of the tongue. When we examine them in a ſound tongue with a good microſcope, we find their convex ſides full of ſmall holes or pores, like the end of a thimble.

They lie chiefly in the middle and anterior portions of the tongue, and are ſometimes moſt viſible on the edges. They appear to be very ſmooth and poliſhed even to the naked eye, and they are often ſeen in living ſubjects. They ſoon loſe their conſiſtence after death, ſo that, by rubbing them ſeveral times, they may be drawn out in form of ſmall ſoft pyramids inclined to one ſide.

The papillae of the third kind, or villoſae, are the ſmalleſt and moſt numerous. They fill the whole ſurface of the upper ſide of the tongue, and even the interſtices between the other papillae. They would be more properly named *papillae conicae* than *villoſae*, from the figure which they appear to have when examined through a microſcope in clear water. They are naturally ſoftiſh, but they become extremely flaccid after death, ſo that by handling them they may be made ſhort and thick, whereas they are naturally long and ſmall. Anatomiſts conſider theſe as the extremities of the veſſels and nerves of the tongue.

The fleſhy fibres of which the tongue is compoſed, and which go no further than the tongue, may be termed *muſculi linguae interiores*. The fibres theſe muſcles conſiſt of are of three general kinds; longitudinal, tranſverſe, and vertical; and each of theſe ſituations admits of different degrees of obliquity. The longitudinal fibres point to the baſis and apex of the tongue, and ſeem partly to be expanſions of the muſculi ſtylogloſſi, hyo-gloſſi, genio-gloſſi, and lingualis. The vertical fibres ſeem likewiſe to be in part produced by theſe muſcles.

Beſides theſe mixed productions, there is a diſtinct plane of longitudinal fibres, which run near the ſurface of the upper ſide of the tongue, and a diſtinct tranſverſe plane under them. All theſe fibres are partly interwoven, one portion of them terminating at the two edges of the tongue, and the other at the baſis and point, without going to any other part; and they lie immediately above thoſe that belong to the genio-gloſſi. To diſcover all theſe different fibres, and their different degrees of direction, we need only cut the tongue longitudinally, after it has been boiled, or long macerated in ſtrong vinegar.

The muſculi exteriores, are thoſe which by one extremity make a part of the body of the tongue, and are fixed by the other in ſome part without the tongue. Of theſe we commonly

monly reckon three pairs; ſtylo-gloſſi, hyo-gloſſi, genio-gloſſi.

The muſcles which move the os hyoides belong likewiſe to the tongue. The names of theſe are, *Mylo-hoidaei*, *genio-hyoidaei*, *ſtylo-hyoidaei*, *omo-hyoidaei*, *ſterno-hyoidaei*.

When either of the ſtylo-gloſſi acts, it turns the tongue toward the cheek, and forces the aliment between the upper and lower molares. When they act jointly with the lateral portions of the ſuperior fleſhy plane of the tongue, they turn the tongue obliquely upward to the teeth of the upper jaw, and near the cheeks, as when we bring down any part of the food that may have ſtuck there after maſtication. When they act jointly with the lateral portions of the hyo-gloſſi, they turn the tongue downward between the lower teeth and the cheek.

When all the parts of the hyo-gloſſi act together, they ſhorten the tongue. They likewiſe turn the point of the tongue between the teeth and the upper lip, and make it paſs over that lip. The ſuperior fleſhy plane of the body of the tongue bends it upward toward the palate, and makes it paſs along and lick the upper lip.

The tongue is fixed in the mouth, not only by muſcles, but alſo by ligaments, which are for the moſt part membranous. The principal ligament is that called the *fraenum*, which is the prominent fold that appears firſt under the tongue when we raiſe it, with the mouth opened; and is no more than a continuation or looſe duplicature of that membrane which covers the inferior cavity of the mouth. It covers the curvature of the anterior portion of the genio-gloſſi from the point of the tongue, almoſt as high as the middle interſtice between the lower dentes inciſorii.

The other ligaments of the tongue are the ſmall membranous fold which runs along the middle of the convex ſide of the epiglottis to the baſis of the tongue, and the membranous folds

folds which cover the inferior half arches of the ſeptum palati. Theſe three folds are continuations of the membrane which covers the neighbouring parts. The aponeurotie ligaments of the ſtylo-gloſſus may be looked upon as true lateral ligaments of the tongue; and they adhere a little to the lower part of the muſculus pterygoidaeus internus, or anterior.

The principal blood-veſſels of the tongue are thoſe that appear ſo plainly on its lower ſurface on each ſide of the fraenum; and they conſiſt of one artery and one vein, which accompany each other, and are called *arteriae et venae ſublinguales* or *raminae*. The veins lie next the fraenum, and the arteries on the other ſide of the veins. The arteries are rami of the ſecond internal or anterior branch of the external carotid on each ſide, and communicate with the firſt external or poſterior branch of the ſame carotid, &c. The veins are commonly rami of a branch of the external jugular vein, deſcribed among the other veins.

We obſerve ſix nervous ropes to go very diſtinctly to the baſis of the tongue, and to continue their courſe through its whole ſubſtance all the way to the point. Two of theſe ropes are rami of the inferior maxillary nerves, or of the third branch of the fifth pair; other two are the nerves of the ninth pair; and the remaining two are ſmall portions, or the firſt branches of the eighth pair.

The great lingual nerve on each ſide runs forward between the muſculus mylo-hyoidaeus and hyo-gloſſus, under the geni-gloſſus, and is diſtributed to the fleſhy fibres all the way to the point of the tongue, communicating by ſeveral ſmall filaments with the lingualis minor, and with the nerve from the eighth pair. For the other diſtributions of it, we refer to the deſcription of the nerves.

The ſmall lingual nerve on each ſide goes off from the maxillaris inferior, ſometimes at, and ſometimes before, its paſſage

paſſage between the pterygoid muſcles. Afterwards, ſeparating more and more from the trunk, it paſſes under the lateral part of the tongue, over the ſublingual gland; of which hereafter. It ſupplies the neareſt parts of the tongue as it paſſes; and then entering its ſubſtance, terminates at the point, having ſent a great number of filaments to the papillary membrane. It communicates, as has been ſaid, with the lingualis major, and with the nerve from the eighth pair.

This lingual nerve, a little after it leaves the maxillaris inferior, receives the chorda tympani, which was formerly mentioned in deſcribing the ear.

This ſmall nervous rope has been looked upon by anatomiſts as a kind of ſmall recurrent of the nervus lingualis; but as, in ſome ſubjects, it appears to make ſimply an acute angle with the lingual nerve, and as this lingual nerve is ſometimes larger after this angle, it ought rather to be believed to come from the tympanum, and to unite with the lingual nerve, than to ariſe from this nerve, and run up to the tympanum. In ſome ſubjects, the union of this nerve with the lingualis is in a manner plexiform, and very difficult to be unfolded.

The lingual nerve of the eighth pair, which is its firſt branch, runs, firſt of all, on the inſide of the digaſtric muſcle of the lower jaw, and ſupplies the geno-hyoidaei, the neighbouring muſcles of the baſis of the tongue, and thoſe of the pharynx. Afterwards, it ſends out the ramifications, and forms the communications deſcribed in the hiſtory of the nerves; and, laſtly, goes to the lower part of the tongue, where it communicates with the lingual ramus of the fifth pair, and with the lingual ramus of the ninth.

The tongue is the organ of that ſenſe called the *taſte*; and, by certain experiments, it appears that the power of taſte is exerciſed by the tongue chiefly, although it is not confined to the tongue alone. For, on whatever part of the mouth, palate,

late, or cheeks, we apply a ſapid body, we do not perceive the ſenſe of pain, but of taſte; and from ſome bodies, as alum, pepper, &c. the ſenſation produced will be ſtronger and more diſtinct in theſe parts than any where elſe. That ſenſation which is ſometimes excited in the ſtomach, oeſophagus, and fauces, by the regurgitation of the aliments, ſeems alſo to belong to the tongue, to which the ſapid vapours are ſent back, uncommonly acrid and penetrating; and even that ſenſe which is ſometimes occaſioned in the ſtomach, oeſophagus, and fauces, from a riſing of the aliments, ſeems alſo to be owing to the tongue, to which the taſteable vapours are conveyed.

The *papillae* of the tongue, which are larger and ſofter than thoſe of the ſkin, and perpetually moiſt, perform the office of touch more exquiſitely than the ſmall and dry cutaneous papillae. The papillae of the tongue being raiſed a little protuberant to perform the office of taſte, are affected in a particular manner by ſalts diſſolved in water, or ſaliva, and applied againſt their tips or ſummits; which being diſtinguiſhed by the mind, and referred to certain claſſes, are called *taſtes*, either four, ſweet, acerb, bitter, ſaline, urinous, ſpiritous, aromatic, or pungent and acrid, inſipid, putrid, and others reſulting partly from pure ſalts, and in part from an intermixture of the ſubtile, animal, or vegetable oils, variouſly compounding and changing each other.

Does the diverſity of taſtes ariſe from the different figures which are natural to ſalts? Is the cubical figure of ſea-ſalt the reaſon of its having a different taſte from nitre that is priſmatical, or from other ſalts of a different form? We anſwer, that this does not ſeem probable; for, even taſteleſs cryſtals have their particular configurations; and the taſte ariſing from very different ſalts, and differently qualified objects of this ſenſe, are too much alike each other, and at the ſame time too inconſtant or changeable, to allow ſuch a theory; as, for example, in nitre. The mechanical reaſon, therefore,

of

of the diverſity of taſtes, ſeems to reſide in the intrinſic fabric of the elements of ſapid bodies, which do not fall under the ſcrutiny of our ſenſes.

But the nature or diſpoſition of the covering with which the papillae are clothed, together with that of the juices, and of the aliments lodged in the ſtomach, have a conſiderable ſhare in determining the ſenſe of taſte; inſomuch, that the ſame flavour does not equally pleaſe or affect the organ in all ages alike, nor in perſons of all temperaments; nor even in the ſame perſon at different times, and in different ſtates of health or diſeaſe. In general, whatever contains leſs ſalt than the ſaliva itſelf, ſeems inſipid.

The ſpirituous parts, more eſpecially of vegetables, either penetrate into the papillae themſelves, or elſe are abſorbed by the adjacent villi of the tongue; as appears from the ſpeedy reſtitution of the ſtrength by vinous, or aromatic liquors. For this reſtitution takes place even before they are received into the ſtomach.

Nature deſigned the difference of taſtes to be felt by the tongue, that we might know and diſtinguiſh ſuch foods as are moſt ſalutary; for, in general, there is not any one kind of wholeſome aliment that is of a diſagreeable taſte; nor are there any ill taſted ſubſtances that are fit for our nouriſhment. By exceſs, indeed, the moſt wholeſome food becomes prejudicial. Nature has invited us to take neceſſary food, as well by the pain called hunger, as by the pleaſure ariſing from the ſenſe of taſte. But brute animals, who have not, like us, the advantage of learning from each other by inſtruction, have the faculty of diſtinguiſhing flavours more accurately, by which they are admoniſhed cautiouſly to avoid poiſonous or unwholeſome food; and therefore it is that, in herbivorous cattle, to which a great diverſity of noxious plants is offered among their food, the tongue is of a more

exquiſite texture, and furniſhed with larger and longer papil lae than in man, to whom they are leſs neceſſary.

The tongue is likewiſe one of the principal inſtruments of ſpeech, and of the articulation of the voice. Riolan, in his Anthropographia, mentions a child of five years of age, who, though he had loſt his tongue by the ſmall-pox, but not the uvula, continued ſtill to ſpeak almoſt as diſtinctly as before. Probably the baſis of the tongue ſtill remained. M. de Juſſieu has publiſhed an obſervation in the Memoirs of the Royal Academy, concerning a little girl who could ſpeak though ſhe was born without a tongue; in room of which there was only a kind of ſmall tubercle.

The tongue ſerves alſo to collect all the morſels which we chew; to turn them in different manners, and to different parts of the mouth; and to rub off whatever ſticks to the palate; and it is uſeful in ſpitting, ſucking, &c. It bears a great part in deglutition, being aſſiſted by the digaſtric muſcles; which, by contracting at the ſame time that the other muſcles preſs the lower jaw againſt the upper, raiſe the os hyoides, and fix it at a convenient height; that the ſtylogloſſi and hyo-gloſſi may make the baſis of the tongue bear back upon the morſel which is to be ſwallowed, and ſo force it into the pharynx; the portions of which, that are at that time immediately above the morſel, inſtantly contract, and puſh it into the oeſophagus.

§ 4. *The Larynx.*

The larynx forms the protuberance in the upper and anterior part of the neck, called commonly *pomum Adami*. This is larger and more prominent in men than in women.

It conſiſts chiefly of five cartilages; the names of which are theſe: Cartilago-thyroides, which is the anterior and largeſt; cricoides, the inferior, and baſis of the reſt; two arytenoides,

arytenoides, the posterior and smallest; and the epiglottis, which is above all the rest. These cartilages are connected together by ligaments, and they have likewise muscles, glands, membranes, &c. belonging to them.

Cartilago thyroidaea. The cartilago thyroidaea is large and broad, and folded in such a manner as to have a longitudinal convexity on the foreside, and two lateral portions, which may be termed *alae*. The upper part of its anterior middle portion is formed into an angular notch; the upper edge of each ala makes an arch; and, together with the middle notch, these two edges resemble the upper part of an ace of hearts in playing cards

The lower edge of each ala is more even, and the posterior edges of both are very smooth, being lengthened out, both above and below, by apophyses, which we name the *cornua of the thyroid cartilage*. The superior apophyses are longer than the inferior; and the extremities of all the four are rounded like small heads, which in the inferior apophyses have a shining surface on the inside, resembling an articular eminence.

On the outside of each ala, near the edge, is a prominent oblique line, which runs from behind forward. The upper extremity of this line is near the superior apophysis or cornu; and both that and the lower extremity end in a small tuberosity, the lowest being often the most considerable. These tuberosities serve for the insertion of muscles and ligaments. The inside of the alae and the convex side of the anterior portion are very uniform; and this cartilage ossifies gradually in old age.

Cartilago cricoides. The cricoid cartilage resembles a kind of thick, irregular ring, very broad on one side, and narrow on the other; or it may be compared to a small portion of a thick tube, cut horizontally at one end, and very obliquely at the other; and it is distinguished into a basis and top, into an anterior, posterior, and two lateral sides. The basis is almost horizontal

horizontal when we ſtand; and to this the aſpera arteria is connected; ſo that the cricoides may be looked upon as the upper extremity of the trachea.

The poſterior portion of the cricoides is larger than the reſt; and its poſterior or convex ſide is divided by a longitudinal eminence, or prominent line, into two diſtinct ſurfaces, for the inſertion of muſcles. The top is gently ſloped above this prominent line; and terminates on each ſide by a kind of obtuſe angle, formed between it and the oblique edge of each lateral portion of this cartilage. At the upper part of each of theſe angles, there is a very ſmooth articular ſurface, gently convex.

The whole poſterior ſide is diſtinguiſhed into two lateral portions by two prominent lines, each of which runs down almoſt in a ſtraight direction from the articular ſurface at the top, a little below the middle of this ſide, where it terminates in another articular line a little concave; and near theſe four articular ſurfaces there are ſmall tubercles. The two ſuperior ſurfaces are for the articulation of the cartilagines arytenoidaeae, and the two inferior for the articulation of the inferior cornua or appendices of the cartilago thyroides.

Cartilagines arytenoidaeae. The cartilagines arytenoidaeae are two ſmall, equal, ſimilar cartilages, which, joined together, reſemble the ſpout of an ewer; and they are ſituated on the top of the cricoides. In each, we may conſider the baſis; cornua; two ſides, one poſterior and concave, the other anterior and convex; and two edges, one internal, the other external, which is very oblique. The baſes are broad and thick; and have each a concave articular ſurface, by which they are joined to the cricoides.

The cornua are bent backward, and a little toward each other. In ſome ſubjects they are very looſe, appearing like true appendices, and eaſily ſeparable from the reſt. Between

their

their inner edges they form a kind of fiſſure, and their outer oblique edges each terminate by a thick prominent angle.

Epiglottis. The epiglottis is an elaſtic cartilage, ſomewhat of the figure of the tongue, narrow and thick at the lower part, thin and ſlightly rounded at the upper part, gently convex on the foreſide, and concave on the backſide. It is ſituated above the anterior or convex portion of the cartilago thyroides; and its lower extremity is tied by a ſhort, broad, and very ſtrong ligament, to the middle notch in the upper edge of that cartilage. It is perforated by a great number of ſmall holes, which are hid by the membranes that cover its two ſides.

Ligaments of the larynx. The cartilago thyroides is connected to the cricoides by ſeveral ſhort ſtrong ligaments, round the articulations of the two inferior cornua with the lateral articular ſurfaces of the cricoides. The apices of the ſuperior cornua are fixed to the poſterior extremities of the great cornua of the os hyoides, by ſlender round ligaments, about a quarter of an inch in length.

In the middle of each of theſe ligaments, we often meet with a ſmall cartilage of an oval figure, and much thicker than the ligaments. The thyroides is likewiſe connected to the os hyoides by a ſhort, broad, ſtrong ligament; one end of which is inſerted in the ſuperior notch of the cartilage, and the other in the lower edge of the baſis of the bone. It has alſo two ligaments at the middle of the concave ſide which belong to the arytenoidaeae.

The cricoides is tied to the lower part of the thyroides by a ſtrong ligament; and by the ligaments already mentioned, to the inferior cornua of that cartilage. Its baſis is fixed to the firſt cartilaginous ring of the trachea arteria, by a ligament exactly like thoſe by which the other rings are connected together; and the membranous or poſterior portion of the

the trachea is likewiſe fixed to the poſterior part of the baſis of the cricoides.

Glottis. The cartilagines arytenoidaeae are connected to the cricoides by ligaments, which ſurround their articulations with the top of that cartilage. Anteriorly the baſis of each arytenoides is fixed to one end of a ligamentary cord, which, by its other end, is inſerted about the middle of the concave ſide of the anterior portion of the thyroides. At their inſertions in the thyroides, theſe two ligaments touch each other; but a ſmall ſpace is left between them, where they are fixed in the two arytenoides; and they ſeem likewiſe to have a ſmall adheſion to the top of the cricoides. This is what is called *the glottis.*

Under theſe two ligamentary cords there are two others which run likewiſe from behind forward. The interſtice between the ſuperior and inferior cords on each ſide form a tranſverſe fiſſure, which is the opening of a ſmall membranous bag, the bottom of which is turned outward, that is, toward the ala of the thyroides. Theſe two ſacculi are the ventricles mentioned by the antients, and reſtored by M. Morgagni, who has given an excellent deſcription of them. They are chiefly formed by a continuation of the internal membrane of the larynx, and the inner ſurface of their bottom ſometimes appears to be glandular.

On the anterior ſurface of the arytenoid cartilages, there is a ſmall depreſſion between the baſis and the convex upper part. This depreſſion is filled by a glandular body, which not only covers the anterior ſurface of each arytenoides, but is likewiſe extended forward from the baſis over the poſterior extremity of the neighbouring ligamentary cord. They are larger and more ſenſible in ſome ſubjects than in others; and they are covered by the membrane which lines the neighbouring parts. Theſe glands were diſcovered by M. Morgagni.

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The two ligaments which connect the epiglottis to the notch of the thyroid cartilage, and to the basis of the os hyoides, and a third, which ties the basis of the os hyoides to the notch of the thyroides, form a triangular space filled with a cellular or fatty substance, and with small glands.

The epiglottis has likewise two lateral ligaments, by which it is connected to the arytenoides all the way to their points or cornua. It has also a membranous ligament, which, running along the middle of its anterior or concave side, ties it to the root or basis of the tongue. This ligament is only a duplicature of the membrane which covers the epiglottis, continued to the neighbouring parts. Lastly, there are two lateral membranous ligaments belonging to it, fixed near the glandular bodies called *amygdalae*.

The epiglottis is not only perforated by the regular holes already mentioned, but has likewise a great number of small irregular fissures and breaks, which are so many different lacunae situated between its two membranes, and filled with small glands, the excretory orifices of which are chiefly on the back-side of this cartilage.

Muscles of the larynx. The larynx gives insertion to a great number of muscles, which may be divided into common, proper, and collateral. The common muscles, according to the general acceptation of that term, are all those that move the whole body of the larynx, one extremity of them being inserted in other parts; and these are reckoned to be four in number, two for each side, viz. sterno-thyroidaei, thyro-hyoidaei or hyo-thyroidaei.

The proper muscles are those inserted wholly in the larynx, and which move the cartilages separately. These have been divided in various manners, but may be all reduced to the following pairs: crico-thyroidaei; crico-arytenoidaei laterales; crico-arytenoidaei posteriores; thyro-arytenoidaei; arytenoidaei; thyro-epiglottici; aryteno-epiglottici.

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By the collateral muſcles, is underſtood thoſe which are inſerted by one portion in the larynx, without appearing to contribute any thing to its motions. Of this kind are the thyro-pharyngaei, crico-pharyngaei, &c.

The larynx may likewiſe be moved by muſcles which are not immediately inſerted in it, but are wholly in other parts. Such are the mylo-hyoidaei, genio-hyoidaei, ſtylo-hyoidaei, omo-hyoidaei, ſterno-hyoidaei, and eſpecially the digaſtrici of the lower jaw, by reaſon of their particular adheſion to the os hyoides. It is likewiſe probable, that thoſe muſcles of the pharynx, which are inſerted in the baſis cranii, may, in certain circumſtances, move the larynx in ſome ſmall degree. The blood-veſſels of the larynx, &c. are the arteriae and venae, thyroideae, ſuperiores, and inferiores. The nerves are the ſuperior and inferior laryngeals, which are branches of the eighth pair.

Uſes. The larynx ſerves particularly to admit and let out the air in reſpiration; and the ſolidity of the pieces of which it is compoſed, hinders not only external objects, but alſo any hard thing which we ſwallow, from diſordering this paſſage. The glotttis being a narrow ſlit, modifies the air which we breathe; and, as it is very eaſily dilated and contracted, it forms the different tones of the voice, chiefly by means of the different muſcles inſerted in the cartilagines arytenoidaeae, to which the other muſcles of the larynx, both proper and common, are aſſiſtants.

The whole larynx is likewiſe of uſe in deglutition, as has been already obſerved, by means of its connection with the os hyoides, to which the digaſtric muſcles of the lower jaw adhere; which muſcles raiſe the larynx, together with the os hyoides, every time we ſwallow.

The facility of varying and changing the tone of the voice depends on the flexibility of the cartilages of the larynx, and decreaſes in proportion as we advance in age; becauſe theſe cartilages

cartilages gradually harden and offify, though not equally ſoon in all perſons: And this change happens not only in the cartilago thyroides, but alſo to the cricoides and arytenoides.

The muſculi ſterno-thyroidaei ſerve in general to pull down the thyroid cartilage, and the whole larynx along with it. They may likewiſe aſſiſt the ſterno-hyoidaei in its action, and compreſs the thyroid gland; of which hereafter. The thyro-hyoidaei may, as occaſion requires, either draw up the larynx towards the os hyoides, or draw that bone downward toward the cartilago-thyroides.

It is difficult to determine the uſe of the crico-thyroidaei from their ſituation. They may either pull the cricoides obliquely backward, or the thyroides obliquely forward; and by this action the inferior cornua of the thyroides, and ſmall articular ſurfaces of the cricoides, muſt ſlide upon each other.

Both the lateral and poſterior crico-arytenoidaei may ſeparate the arytenoid cartilages, and thereby open or dilate the glottis; but they do not both perform this action in the ſame manner. The lateral muſcles ſeparate theſe cartilages obliquely forward, and at the ſame time looſen or relax the ſides of the glottis; but the poſterior muſcles ſeparate them obliquely backward, and at the ſame time ſtretch or extend the ſides of the glottis; and when both muſcles act equally, they ſeparate the cartilages directly.

The thyro-arytenoidaei acting together, draw both the arytenoid cartilages forward, and conſequently looſen the glottis, and render it capable of the ſmalleſt quaverings of the voice. They may likewiſe probably compreſs the lateral ſinuſes or ventricles of the larynx, and alſo the arytenoid glands.

The arytenoidaei bring the arytenoid cartilages cloſe together, and preſs them againſt each other; and when the cartilages are in this ſituation, they may at the ſame time be in-

clined either forward by the thyro-arytenoidaei, or backward, by the crico-arytenoidaei posteriores. By this means the glottis, when shut, may be either relaxed or tense; and, in this last case, it is entirely shut, as when we hold in our breath in straining: But of this more in another place.

The general use of the epiglottis is to cover the glottis like a pent house, and thereby hinder any thing from falling into it when we eat or drink; and for this purpose it is depressed in the manner that shall be shewn hereafter. It serves likewise to hinder the air which we inspire from rushing directly upon the glottis; but, by splitting it, as it were, obliges it to enter by the sides, or in an oblique course. The muscles of the epiglottis do not appear to be absolutely necessary for that cartilage; for in deglutition it may be sufficiently depressed by the basis of the tongue, and it may rāise itself by its own elasticity. The thyro-epiglottici and aryteno-epiglottici may serve to shut any lateral openings that might remain when the epiglottis is depressed by the basis of the tongue; and the hyo-epiglottici may pull it a little forward in strong respirations, as in sighing, yawning, &c.

Voice and Speech. The *larynx* is the principal organ of the voice; for that being injured, the air passes through the windpipe without yielding any sound.

All the cartilages of the larynx are connected by various muscles and ligaments, with a certain degree of firmness, to the adjacent parts; and yet so that the whole is easily moveable together, as are also its several parts upon each other.

We shall now consider what action the air produces, when it is driven from the lungs in exspiration through the trachea into the larynx, and through the glottis into the mouth. The consequences or effects of this are, voice, speech, and singing. The voice, indeed, is only formed, when the air is expelled with so great a velocity through the contracted glot-

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tis, that it ſplits or makes a colliſion upon the ligaments of the glottis, ſo as to put the larynx into a tremor, which tremor is returned, and continued and increaſed by the elaſticity of theſe parts. From the conjunct trembling of the ligaments and cartilages of the larynx, a ſound is produced which we call the *voice*. It is different in different animals, and depends entirely on the form and ſtructure of the larynx and glottis. When a trembling is not excited, the exſpired air cauſes a whiſper.

The ſtrength of the voice is proportional to the quantity of air blown out, together with the narrowneſs of the glottis; and, therefore, a large pair of lungs eaſily dilatable, an ample cartilaginous and elaſtic larynx and windpipe, a free echo of the noſtrils, and a powerful exſpiration, all conduce to this effect. But acute and grave tones of the voice, we obſerve to ariſe from various cauſes; the former proceeds from a tenſion and narrowneſs of the glottis, and the latter from a relaxation and expanſion of it. In the former, a greater number of aërial undulations are ſplit in the ſame time upon the ligaments of the glottis, whence the tremors excited in the ſame time are more numerous; but, when the glottis is dilated, the contrary of all this follows. And moreover, from the greater tenſion of the ligaments, the tremors become more numerous from the ſame ſtroke; therefore, to produce an acute and ſhrill voice, the whole larynx is drawn upwards and forwards, and ſo much the more as the voice is required to be ſharper, inſomuch that the head itſelf is inclined backwards, by which the powers of the muſcles elevating the larynx are rendered more full and effectual. The truth of this is confirmed by applying the fingers to the larynx when it forms an acute ſound; for then, to raiſe the voice an octave, you will eaſily perceive it to aſcend near half an inch. It is alſo confirmed by comparative anatomy, which diſcovers the narroweſt glottis and the cloſeſt approximation of cartilages

lages in ſinging birds, but an ample or broad glottis in hoarſe animals, and ſuch as bellow or bleat. We obſerve the ſame fact in whiſtling, where the voice becomes manifeſtly more acute by a contraction or narrowneſs at the mouth: Alſo in muſical inſtruments, in which a narrowneſs of the mouth, with a celerity of the wind blown out, are the cauſes of an acute or ſhrill tone.

Gravity of the voice, on the contrary, follows from a depreſſion of the larynx by the cauſes already deſcribed; to which add a broad glottis and a very ample larynx. This is evident to the touch of the finger applied to the larynx when a perſon ſings, by which the deſcent of it is manifeſtly perceived to be about an inch for every octave: Hence the voice of males is more grave; and hence the loweſt degrees of the voice degenerate into a muteneſs or whiſpering.

Is the whole difference of tone owing to the length of the ligaments of the glottis, which is augmented when the ſcutiform cartilage is drawn forward, and the arytenoid ones backward? Are acute tones produced in proportion as the ligaments are ſtretched, and thus vibrating with great celerity? This has been confirmed by repeated experiments; and ſome late anatomiſts have obſerved, that, when the cords or ligaments of the glottis are tenſe, the peculiar voice of every kind of animal is produced by blowing air into its larynx: That this voice was more acute as the ligaments were more tenſe, and more grave as they were ſlackened; that, by ſhutting the whole ligament, the voice was ſuppreſſed; by ſhutting the half, the voice was rendered an octave higher; by ſhutting a third part, a fifth higher, &c. There are not wanting, however, doubts concerning this new theory, ariſing from the cartilaginous and bony ſtructure of the glottis of birds, which of conſequence muſt be immoveable, and not extenſible; from the voice moſt certainly becoming more acute, in whiſtling, from the mere contraction of the lips;

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from the example of women, in which the larynx is ſofter, but the voice more acute, than in men; from experiments which ſhew, that more acute ſounds are produced by bringing the ligaments of the glottis nearer into contact with each other; from the perfect want of machines, by which the ligaments can be ſtretched, and the ſcutiform cartilage brought forward from the annular one. But, ſince it appears from experiments, that a tenſion of the ligaments ſuffices for producing acute ſounds, without the contraction of the glottis, we may believe that the different tenſion of the glottis contributes more to the diverſity of voice than the different diameter of it.

Singing is when the voice, modulated through various degrees of acuteneſs and gravity, is expelled through the larynx, while it is trembling and ſuſpended between two contrary powers; and herein lies the principal difference between the chanting of ſimple notes and the expreſſion of words. Hence ſinging appears to be a laborious action, on account of the continual contractions of the muſcles, which keep the larynx at an equilibrium; and hence it is that ſinging makes a perſon hot; becauſe, in acute tones, the narrower glottis much retards the exſpiration, while at the ſame time a great deal of air is required to give ſtrength to the voice; to which, again, deep inſpirations are neceſſary. Hence likewiſe the trachea grows dry, from the quicker paſſage or current of air; to prevent which, a great deal of mucus is required; and therefore great numbers of mucous receptacles are found in the larynx; among which the ventricles before deſcribed ought ſurely to be numbered.

Speech is performed by the larynx at reſt, or held in the ſame place, with tones of voice differing but little in acuteneſs and gravity; but then the voice is variouſly changed or modulated by the organs of the mouth. Singing has a variation in the tone or cadence of the voice, together with a

modulation

modulation of it by the organs of the mouth at the ſame time.

All ſpeech is reducible to the pronunciation of letters, which differ in various nations; but their general properties are alike all the world over. Of theſe, ſome are called *vowels*, which are made by an expreſſion of the voice, without any application of the tongue to certain parts of the mouth. But *conſonants* are formed by a colliſion of the tongue againſt certain parts of the mouth, lips, and teeth. But, to be more particular in theſe matters is beyond our purpoſe, which does not permit us to expatiate upon the beautiful art of pronunciation. That art, as an extraordinary inſtance of mechanical knowledge, has ſo accurately determined all the corporeal cauſes concurring to each letter, that, by inſpection only, with the aſſiſtance of touch, letters pronounced are underſtood without hearing them; and the attentive perſon is thereby taught to imitate the ſame ſpeech by a like uſe of the organs.

§ 5. *The Pharynx.*

The pharynx is a muſcular and glandular bag; the outer ſurface of which is cloſely joined to the inner ſurface of all that ſpace which is at the bottom of the mouth, behind the poſterior nares, uvula, and larynx, and which reaches from the cuneiform proceſs of the os occipitis all the way to the oeſophagus, which is a continuation of the pharynx. This ſpace is bounded poſteriorly by the muſcles which cover the bodies of the firſt vertebrae of the neck, and laterally by the ſuperior portions of both the internal jugular veins and of both the internal and carotid arteries, by the ſpinal apophyſes of the os ſphenoides, by the extremities of the apophyſes petroſae, by the os ſphenoides immediately above the internal alae of the apophyſes pterygoides, and by the neighbouring portion of both pterygoid muſcles.

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From these limits and adhesions of the pharynx we may nearly determine its figure. It may be compared to the wide part of a covered funnel, of which the oesophagus is the narrow part or tube; or it may be called the *broad end of the oesophagus*, that and the pharynx taken together being compared to a trumpet. The pharynx may be divided into three parts; one superior, which is the arch of the pharynx; one middle, which is the body or great cavity; and one inferior, which is the bottom, narrow portion, or sphincter. We are likewise to observe it in three openings; that of the arch toward the nares; that of the body, toward the mouth; and that of the bottom, toward the oesophagus.

The arch is the broadest part of the pharynx; and ends on each side in an angle or point, toward the jugular fossulae of the basis cranii. Afterwards the great cavity contracts a little towards the sides, all its other dimensions continuing the same; and behind the larynx it is again enlarged on each side, a very small space being left between it and the cricoid cartilage. The extremity of the lower portion is very narrow, and joins the basis of the cartilage just named.

The pharnyx consists partly of several distinct fleshy portions, which are looked upon as so many different muscles so disposed as to form a large cavity; and partly of a membrane which lines the inner surface of this whole cavity, and is a continuation of that of the nares and palate.

This membrane is wholly glandular; and it is thicker on the superior and middle portions of the pharynx than on the bottom or lower portion. Immediately above the first vertebra it forms several longitudinal rugae very thick, deep, and short; and we generally find therein a collection of mucus in dead bodies. In the great cavity there are no rugae, the membrane adhering, both there and in the upper part, very closely to the muscles. At the lower part, where it is thinnest, it covers likewise the posterior part of the larynx; and

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is very loose, and formed into irregular folds. It runs in a little on each side between the edges of the pharynx.

Muscles of the pharynx. Though almost all the muscular or fleshy portions of which the pharynx is composed, concur in the formation of one continued bag or receptacle, they are nevertheless very distinguishable from each other, not only by their different insertions, from which they have been denominated, but also by the different directions of their fibres. They may be looked upon as three digastric muscles; the middle tendons of which lie backward in one longitudinal line, which in some subjects appears plainly like a linea alba.

The lowest of the muscular fibres make a complete circle backward between the two sides of the basis of the cartilago cricoides. This circle is the beginning of the oesophagus, and has been thought by some to form a distinct muscle, called *oesophagus*. Besides the muscles which form the body of the pharynx, there are several other small ones connected with it; but of these sufficient descriptions have been already given in a former part of the work.

The particular uses of these muscles are very difficult to be determined. It is certain that those of the middle and lower portions of the pharynx serve chiefly for deglutition. Those of the upper portion, and some of those of the middle portion, may, among other functions, be useful in modifying the voice, according to the opinion of M. Santorini.

§ 6. *The Salival Glands, &c.*

By saliva we mean in general that fluid by which the mouth and tongue are continually moistened in their natural state. This fluid is chiefly supplied by glands, called for that reason, *glandulae salivales*, of which they commonly reckon three pairs, two parotides, two maxillares, and two sublinguales. These are indeed the largest, and they furnish

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the greateſt quantities of ſaliva; but there are a great number of other leſſer glands of the ſame kind, which may be reckoned aſſiſtants or ſubſtitutes to the former. All theſe may be termed *ſalival glands*, and they may be enumerated in the following manner: Glandulae parotides, glandulae maxillares, glandulae ſublinguales, glandulae molares, glandulae buccales, glandulae labiales, glandulae linguales, amygdalae, glandulae palatinae, glandulae uvulares, glandulae arytenoidaeae, glandula thyroidaea.

The parotides are two large, whitiſh glands, irregularly oblong and protuberant, ſituated on each ſide, between the external ear and the poſterior or aſcending ramus of the lower jaw, and lying on ſome part of the neighbouring maſſeter muſcle. The ſuperior portion of this gland lies before the cartilaginous meatus of the ear, and touches the apophyſis zygomatica of the os temporis; and it is extended forward and backward under the lobe of the ear, as far as the maſtoid apophyſis.

From the anterior and ſuperior portion of this gland, a white membranous duct or canal is produced by the union of a great number of ſmall tubes repreſenting ſo many roots. This duct runs obliquely forward on the outſide of the maſſeter; and then perforates the buccinator from without inward, oppoſite to the interſtice between the ſecond and third dentes molares, where the hole or orifice repreſents the ſpout of an ewer.

This canal is named *ductus ſalivalis Stenonis*, or *ductus ſuperior*. It is about the twelfth part of an inch in diameter, and on the outer ſide of the maſſeter muſcle it receives ſometimes one and ſometimes two ſmall ducts, from a like number of little glands, which Haller calls *glandulae acceſſoriae*. The external carotid artery and vein, and the portio dura of the ſeventh pair of nerves, paſs through the ſubſtance of the paro-

tid gland, to which they give branches; and the facial artery and vein pafs over its duct.

The maxillary glands are fmaller and rounder than the parotides; and are fituated each on the infide of the angle of the lower jaw, near the mufculus pterygoidaeus inferior. From the infide, or that which is turned to the mufculus hyo-gloffus, each of them fends out a duct in the fame manner as the parotides; but it is fmaller and longer, and goes by the name of *ductus falivalis Whartoni, or ductus inferior.*

This duct advances on the fide of the mufculus genio-gloffus, along the inner part and fuperior edge of the glandula fublingualis, to the fraenum of the tongue, where it terminates by a fmall orifice, in form of a papilla.

The glandulae fublinguales are likewife two in number, of the fame kind with the former, only fmaller, fomething oblong, and flatted like a blanched almond. They are fituated under the anterior portion of the tongue, one on each fide, near the lower jaw, on the lateral portions of the mufculi mylo-hyoidaei which fuftain them. The two extremities of each gland are turned backward and forward, and the edges obliquely inward and outward.

They are covered on the upper fide by a very thin membrane, which is a continuation of the membrane that covers the under fide of the tongue. They fend out laterally feveral fmall fhort ducts which open near the gums by the fame number of orifices, all arranged in the fame line, at a fmall diftance from the fraenum, and a little more backward. In many animals we find particular ducts belonging to thefe glands, like thofe of the glandulae maxillares, but they are not to be found fo diftinctly in men. The mufculi genio-gloffi lie between the two fublingual glands, and alfo between the two maxillary ducts. The arteries and veins of thefe, and of the former glands, belong to the lingual veffels, and the nerves are from the lingual branch of the fifth pair.

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The molares are two glands nearly of the ſame kind with the former, each of them being ſituated between the maſſeter and buccinator; and in ſome ſubjects they may be eaſily miſtaken for two ſmall lumps of fat. They ſend out ſmall ducts which perforate the buccinator, and open into the cavity of the mouth, almoſt over againſt the laſt dentes molares; and from thence Mr Heiſter, who firſt deſcribed them, called them *glandulae molares*.

All the inſide of the cheeks, near the mouth, is full of ſmall glandulous bodies, called *glandulae buccales*, which open by ſmall holes or orifices through the inner membrane of the mouth. The membrane which covers the inſide of the lips, which is a continuation of that on the cheeks, is likewiſe perforated by a great number of ſmall holes, which anſwer to the ſame number of ſmall glands, called *glandulae labiales*. The glandulae linguales are thoſe of the foramen caecum of the baſis of the tongue, which have been already deſcribed.

We have alſo explained the glandulae palatinae, or thoſe that belong to the arch and ſeptum of the palate; and the glandulae arytenoidaeae were deſcribed with the larynx. The uvular glands are only a continuation of the membrane of the palate, in form of a ſmall bunch of grapes. We might likewiſe reckon among the ſalival glands thoſe of the ſuperior portion of the pharynx mentioned in the deſcription of that part, and alſo the follicles of the membrana pituitaria of the nares, and of the ſinuſes which communicate with them.

The amygdalae are two glandular bodies of a reddiſh colour lying in the interſtices between the two lateral half-arches of the ſeptum palati, one on the right, the other on the left ſide of the baſis of the tongue. Their appearance is not unlike that of the outſide of an almond ſhell, both becauſe their ſurface is uneven, and becauſe it is full of holes big enough to admit the head of a large pin.

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Theſe holes, which repreſent a ſieve, or a piece of network, are continued to an irregular ſinus or cavity within the gland, filled commonly with a viſcid fluid, which comes from the bottom of the ſinus, aud is from thence gradually diſcharged through theſe holes into the throat.

The thyroid gland is a large reddiſh maſs, which covers the anterior convex ſide of the larynx. It ſeems at firſt ſight to be made up of two oblong glandular portions united by their inferior extremities, below the cricoid cartilage, in ſuch a manner as to have ſome reſemblance to a creſcent, with the cornua turned upward. It is of a moderate thickneſs, and bent laterally like the thyroid cartilage, from which its name is taken. The two lateral portions lie on the muſculi thyroidaei, and the middle or inferior portion on the crico-thyroidaei. The thyro-pharyngaei inferiores ſend fibres over this gland; and they communicate on each ſide, by ſome ſuch fibres, with the ſterno-thyroidaei and hyo-thyroidaei.

This gland ſeems to be of the ſame kind with the other ſalival glands, but it is more ſolid. Some anatomiſts thought they had diſcovered the excretory duct; but they miſtook a blood-veſſel for it. Sabatier obſerves, that the internal ſtructure of this gland is flaccid and reddiſh, and formed of glandulous grains, leſs eaſily diſtinguiſhed than in the other glands, and of veſicles of different ſizes, full of a yellowiſh oily liquor, which may ſerve the purpoſe of lubricating the parts in its neighbourhood. We ſometimes meet with a kind of glandular rope which runs before the cartilago-thyroides, and diſappears before the baſis of the os hyoides.

This glandular rope goes out from the common baſis of the lateral portions of the thyroid gland; and is loſt between the muſculi ſterno-hyoidaei, behind the baſis of the os hyoides, or between that baſis and the epiglottis.

The glandulae lymphaticae will come in more properly in another part of this work, with the deſcription of the abſorbent ſyſtem.

§ 7. *Of Maſtication, Saliva, and Deglutition.*

Such hard and tough foods as conſiſt of long parallel fibres, or are covered with a bony ſhell or cartilaginous ſkin, generally require maſtication to divide them into leſs cohering parts, that they may more eaſily yield their nouriſhment to the diſſolving powers of the ſtomach. The more diligently they are ſubdivided in the mouth, the more reliſhing and agreeable they become to the ſtomach; and the nearer they approach to the nature of a fluid, the more eaſily are they digeſted or aſſimulated.

Moſt animals, therefore, are provided with teeth extremely hard; and, as the materials of our food are various in their texture and firmneſs, nature has accordingly furniſhed us with teeth variouſly figured. The office of the inciſores is only, in the ſofter foods, to cut thoſe which are tougher than the reſt into ſmaller portions; ſuch as the fibres and membranes of animals and vegetables, with the brittle ſeeds and kernels of fruits.

The canine teeth lacerate tough aliments, and hold faſt ſuch as require long trituration by the grinders.

Between the molares the moſt compact foods are interpoſed and broke, the more tough and hard are ground ſmaller, the lower teeth being urged obliquely and laterally againſt the immoveable upper ones. Theſe teeth are the principal inſtruments of maſtication; and, that they might break or grind the food with due ſtrength and firmneſs, the uppermoſt are fixed into the ſockets of the immoveable upper jaw, as the lower ones are into the lower moveable jaw. This lower jaw is a ſingle bone, and ſo joined with the temporal bones, that it may be drawn down from the upper jaw, and pulled up againſt it with a great force; and may be moved laterally

laterally to the right or left, forward and backward. The various motions of the lower jaw have been already described.

The muſcles moving the lower jaw which are weak in a man, but very ſtrong in brute animals, are the temporalis and maſſeter, which act in concert, the temporal muſcle bringing the jaw more backwards, and the maſſeter forwards. The *pterygoidaeus internus* elevates or draws it to one ſide or the other alternately. The *pterygoidaeus externus* draws it forward and ſidewiſe.

The lower jaw is depreſſed, ſo as to open the mouth by the digaſtric or *biventer* muſcle. Moreover, the mouth may be partly opened by all the other lower muſcles of the jaw, os hyoides, and the larynx, as the genio-hyoidaeus, genio-gloſſus, ſterno-hyoidaeus, ſterno-thyroidaeus, coraco-hyoidaeus, and latiſſimus colli; although the later rather draws the ſkin of the neck and face downward than the jaw itſelf. The genio-hyoidaeus and digaſtric muſcles have a power of drawing the jaw backwards.

The lower jaw is elevated with a great force, ſo as to divide the food by the preſſure of the upper and lower teeth againſt each other, by the action of the temporal, maſſeter, and internal pterygoid muſcles, the contraction of which appears by experiments to be very powerful, and ſufficient to raiſe ſeveral hundred weight. The lateral and circular motions of the jaw are performed by the external and internal pterygoidaei, acting either alone or together. Thus the food is cut, lacerated, and ground to pieces; and, if the maſtication be continued, it is, together with the liquors of the mouth, reduced to a kind of pulp.

During the trituration of the food in the mouth, there is continually poured into it, from numerous ſprings, a large quantity of a watery, clear, evaporable, inſipid, or at leaſt but very

very ſlightly, ſaline liquor, containing but little earth *. A large quantity of this *faliva* is ſeparated by numberleſs ſmall glands of the lips and cheeks; and the juice poured out from the exhaling veſſels of the tongue, mouth, and cheeks, is of the like kind, or rather more watery. As for the ductus inciſivus, we are now ſufficiently certain, that, in the generality of perſons, it diſcharges nothing into the mouth, and only gives paſſage to veſſels and nerves running between the palate and noſtrils.

The ſaliva is a watery liquor, with a moderate quantity of ſalt, partly lixivial, and partly culinary; with ſome oil and earth, diſſipable by fire, with ſcarce any taſte, unleſs what is given to it by diſeaſe or famine. The quantity produced is very conſiderable, as twelve ounces have been known to flow out from wounds in thoſe parts in the ſpace of an hour. It is for the moſt part ſwallowed, and indeed it cannot be thrown away without hurting the digeſtion.

By the motion of the jaw in maſtication, the ſalival glands which have been already deſcribed, are compreſſed, ſo as to diſcharge their juices into the mouth in great plenty. When the mouth is opened, the maxillary gland, being preſſed by the digaſtric and mylo-hyoidaeus, throws forth abundance of ſaliva; the maſſeter, when ſwelled, preſſes the parotid gland, as does alſo the cutaneous muſcle of the neck which lies over it: And it is this muſcular preſſure that excites the appetite, and pours the ſaliva into the mouth.

The food being ground between the teeth, and intermixed with the watery ſaliva and air, is broken down into a ſoft, juicy pulp, replete with elaſtic air; the food afterwards undergoes a farther diſſolution from the warmth of the parts cauſing the air to expand, and, by its elaſticity, burſt aſunder the

* This earth is neither acid nor alkaline, although from thence may be obtained a very ſmall portion of lixivial ſalt.

the particles of the food, between which it is included and confined. In this act of maſtication, the oily, aqueous, and ſaline parts of the food are intermixed the one with the other; the ſmell and taſte of different ingredients are loſt in one, which, by the dilution of the ſaline parts with ſaliva, renders the food flavourable; but ſuch particles as are more volatile and penetrating, being directly abſorbed by the bibulous veſſels of the tongue and cheeks, enter ſtraight into the blood veſſels and nerves, ſo as to cauſe an immediate recruit of the faculties.

The motions which are neceſſary for turning round the food, applying it to the teeth, and conveying it through the different parts of the mouth in maſtication, are performed by the tongue, cheeks, and lips. And firſt, the tongue being expanded ſo as to form a ſmall concavity in its back or ſurface, takes up the food, and conveys it to the parts for which it is deſigned. At one time the tongue, rendered narrow by lateral contraction, ſearches every part of the mouth with its tip, and turns out the latent food into a heap on its common concavity. At another time, applying its extremity to the fore-teeth, and raiſing itſelf up ſucceſſively, it draws from the cavity of the mouth the fluids or chewed aliments, and conveys them to the fauces or back part of the mouth behind the teeth.

Theſe motions of the tongue are likewiſe governed by the muſcles and membranes inſerted in the os hyoides; and this bone being drawn down by its reſpective muſcles, depreſſes the tongue, and alſo the lower jaw, if its muſcles be relaxed. Theſe muſcles are the ſterno-hyoidaeus, ſterno-thyroidaeus, hyo-thyroidaeus, thyro-pharyngaeus, and coraco-hyoidaeus.

The other muſcles which elevate the os hyoides, together with the tongue, are the *ſtylo-gloſſus*, ſuſtained by a peculiar ligament of the upper jaw. The *ſtylo-hyoidaeus*, and ſecond *ſtylo-*

hyoidaeus

hyoideus, which, when it is present, resembles the former. All these muscles draw the tongue back, but laterally they elevate it. The *mylohyoidaeus* elevates the tongue, and fixes it in making various motions, or in like manner depresses the jaw. The *geniohyoidaeus*, being a companion of the genioglossus, pulls the tongue forward out of the mouth.

The muscles of the cheeks variously move and press the food in the mouth. Others move it from the cavity of the cheeks into the inner cavity of the mouth behind the teeth, as we see in the buccinator when the mouth is shut. Others open the mouth for receiving the food, such as the double-headed proper elevator of the upper lip, and the elevator anguli oris; to which add the zygomatici, upper and lower; the buccinator, depressor anguli oris, and depressor labii inferioris. Others again close the lips, that the food received may not return out of the mouth; as the orbicularis of each lip, the proper depressor of the upper lip, and the proper elevator of the lower lip, and that which serves in common for the elevation of both.

By these means the food, ground and mixed with the saliva into a soft pulp, collected from all parts of the mouth by the tongue, into the arched space between the teeth, is afterward, by the expansion and successive pressure of the tongue, conveyed backward behind the teeth; and, in this action, the tongue is expanded by the hyoglossi and genioglossi, and rendered a little concave by the styloglossus. And from thence it is next conveyed into the fauces.

For the tongue being raised by the styloglossi, and broadly applied to the palate, first by its apex, then also insensibly by its posterior extremity, presses the food successively towards the fauces, which, at that time, only afford an open passage. After this, the thick root and back part of the tongue itself, by the forementioned muscles, and by the stylohoidaei and biventers carried backward, presses down the epiglottis, which

ſtands up behind the tongue, connected therewith by numerous membranes, and perhaps by ſome muſcular fibres. At the ſame time, the muſcles elevating the pharynx all act together; ſuch as the biventer, geniohyoideus, geniogloſſus, ſtylohyoideus, ſtylogloſſus, ſtylopharyngeus, and the other elevators, which now draw the larynx upward and forward, that the epiglottis, being brought nearer to the convex root of the tongue, may be better cloſed or depreſſed. Hence it is neceſſary toward deglutition, for the jaws to be cloſed, that by this means the biventer may have a firm ſupport, and, together with the muſcles already deſcribed, elevate the os hyoides. Thus the epiglottis, being inverted, ſhuts up and cloſely covers the paſſage into the larynx, over which the aliments paſs, as over a bridge, into the fauces.

The pharynx is dilated in its action by the powers ſerving to its elevation; ſuch as the *ſtylopharyngeus*, the *thyreopalatinus*, &c. and it cloſely ſurrounds and follows the drink, on each ſide of the epiglottis, above the larynx, that it may from thence fall into the oeſophagus.

That the aliment might not regurgitate into the noſtrils at the time when it is preſſed into the dilated pharynx, a moveable velum or palate is interpoſed. The elevator of this velum, with its companion, forms an arch which is moveable with the palate itſelf, between the two plates of the thyreopalatinus muſcle, ſo as to be brought into a cloſe contact with the ſides of the nares and with the tubes, that none of the aliment may enter into either of them. But this elevator does not ſeem to have any conſiderable action in ſwallowing. At this time regurgitation into the noſtrils is prevented by a conſtriction of the muſcles of the pharynx, together with a depreſſure of the thyreo-palatinus, which then manifeſtly draws the moveable velum downward, and towards the tongue and pharynx. Add to theſe, the *circumflexus palati mollis*, which is able both to open the tube, and to preſs down the

the moveable velum of the palate. Thus the pharynx being contracted like a ſphincter, drives down the food, without permitting any part to return into the cavity of the nares. Hence, when the velum of the palate is vitiated, the aliments regurgitate into the noſtrils, and a deafneſs enſues.

During this endeavour to depreſs the food by the pharynx, the velum, drawn back and expanded, is pulled down towards the tongue by the action of the palato-pharyngei, and by the circumflex muſcles of the ſoft palate. Theſe muſcles, together with the gloſſo-palatinus, preſs the velum againſt the protuberant root of the tongue, and intercept any return to the mouth and noſtrils. After there is no further danger of any part falling into the trachea, the epiglottis is raiſed up again, as well by its own elaſticity, as by the elevation of the tongue itſelf, by which it is drawn forward. Laſtly, the depreſſed uvula is raiſed by the azygos, which ariſes from the tendons of the circumflexi muſcles and levator of the ſoft palate.

A little after this follows an attempt to urge the food downward, which is exerted by the conſtrictor muſcles of the pharynx which draw the fore parts towards the back, and by the muſcles, which are partly tranſverſe, and partly aſcend into the poſterior ſurface of the pharynx. Theſe muſcles, acting ſucceſſively from above downward, according to their ſituation, drive the aliment into the oeſophagus. At the ſame time the depreſſing muſcles of the larynx, coracohyoidaeus, ſterno-hyoidaeus, and ſterno-thyreoidaeus, draw down the larynx forward, and leſſening the capacity of the pharynx, urge the food downward. But in this action, as the aliment paſſes by the poſterior rima of the glottis, the arytaenoidei contract the larynx perpendicularly.

As various dry and rough bodies are frequently ſwallowed, it was neceſſary for the pharynx to be dilatable, and not very ſenſible of pain; to which end the great quantity of mucus, which

which is collected in all parts of the fauces, greatly conduces. Therefore, in general, between the nervous and innermoſt coat of the pharynx, a great number of ſimple mucous follicles or cells are placed, pouring out their mucus through ſhort mouths; of a ſoft and ſomewhat watery nature; but ropy and viſcid, abounding with oil and volatile ſalts, and more earth than the ſaliva itſelf.

The aliments are moved through the oeſophagus as through an inteſtine. The longitudinal fibres, aſcending to the cartilages of the larynx, dilate the gullet, oppoſite to the deſcending morſel. But, when it is received, the longitudinal fibres equally dilate and elevate the gullet at that place which receives it. Then that part of the oeſophagus where the morſel is ſeated, being irritated, contracts, and moves the food downward. This muſcle is ſtrong, and very irritable.

The upper opening of the ſtomach is contracted or compreſſed in ſuch a manner, by the lower muſcle of the diaphragm, in every inſpiration, as to confine the food within the ſtomach, and direct it in every exſpiration, by preſſure, naturally towards the pylorus. By this means, the ſtomach is ſo cloſely ſhut, that, in the moſt healthy man, even wind or vapours are confined within it; nor do they ever aſcend but by a morbid affection.

CHAP.

CHAP. II.

Of the Thorax.

BY the thorax we commonly underſtand all that part of the body which anſwers to the extent of the ſternum, ribs, and vertebrae of the back, both outwardly and inwardly.

The thorax is divided into the anterior part, called commonly the *breaſt*; the poſterior part, called the *back*; and the lateral parts, called the *right* and *left ſides*.

The external parts of the thorax, beſides the ſkin and membrana adipoſa, are principally the mammae; and the muſcles which cover the ribs, and fill the ſpaces between them.

The muſcles are the pectorales majores and minores, ſubclavii, ſerrati majores, ſerrati ſuperiores poſtici, latiſſimi dorſi, and vertebrales; and to theſe we may add the muſcles which cover the ſcapula.

The internal parts of the thorax are contained in the large cavity of that portion of the trunk which the ancients called the *middle venter*, but the moderns name it ſimply the *cavity of the breaſt*. This cavity is lined by a membrane named *pleura*, which forms the mediaſtinum, and contains the heart and lungs, with the veſſels, &c. which go in or from them: Through it, likewiſe, the oeſophagus paſſes to the ſtomach; and part of the nerves are contained in it which go to the contents of the abdomen.

External

External conformation of the thorax. The whole extent of the thorax in a living ſubject is commonly determined, not only by the ſternum, vertebrae of the back and ribs, but alſo by all that ſpace contained between the articulations of the two arms with the ſcapulae and claviculae; and in this ſenſe the outſide of the thorax is broader above than below, in a healthy ſubject, who has a moderate ſhare of fleſh on his bones.

The breadth of the upper part of the breaſt is owing to the pectorales majores and latiſſimi dorſi viewed directly forward or backward. But, when we take a direct lateral view of the breaſt, it appears narrower above than below, not only in an entire ſubject, but even after every thing has been removed that covers the ſides of the thorax, and in the ſkeleton itſelf.

The common integuments of the thorax are the ſame with thoſe of the abdomen; and the convex ſide of this part of the body is likewiſe covered by ſeveral muſcles. Anteriorly, we find the pectorales majores and minores, a large portion of the ſerrati majores, the ſubclavii, a portion of the ſcaleni and of the obliqui abdominis externi. Poſteriorly, we have all the muſcles which cover both ſides of the ſcapula, the ſerrati poſtici, and a part of the ſacro-lumbares, longiſſimi dorſi, vertebrales, &c. as in the hiſtory of the muſcles. Among all the external parts of the thorax, only two are peculiar to it in the human body; namely, the two eminences called *mammae*, which muſt therefore be deſcribed in this chapter.

Cavity of the thorax. The hard parts which form the ſides of the cavity of the thorax, are, the twelve vertebrae of the back, all the ribs, and the ſternum. The ſoft parts which complete the ſides are, the membrane called *pleura*, which lines the cavity, and the muſculi intercoſtales, ſterno coſtales, and diaphragma, already deſcribed among the muſcles.

All

All these hard and soft parts, taken together, represent a kind of cage, in some measure of a conical figure, flatted on the foreside, depressed on the backside, and in a manner divided into two nooks by the figure of the vertebrae of the back, and terminated below by a broad arched basis inclined backward. The intercostal muscles fill up the interstices between the ribs, and so complete the sides of the cavity: The basis is the diaphragm; and the pleura not only covers the whole inner surface of the cavity, but, by forming the mediastinum, divides it into two, one on the right, the other on the left.

§ 1. *Mammae.*

The name of *mammae*, or *breasts*, is given to two eminences, more or less round, situated in the anterior, and a little toward the lateral parts of the thorax, their centre or middle part lying almost opposite to the bony extremity of the sixth true rib on each side. Their size and figure vary in the different sexes and different ages.

In children of both sexes, and in males of all ages, they are commonly no more than cutaneous tubercles, or soft verrucae of a reddish colour, called *papillae or nipples*; each of them being surrounded by a small, thin, and pretty broad circle or disk, more or less of a brownish colour, and an uneven surface, termed *areola*.

In females come to the age of puberty, which is sometimes sooner, sometimes later, a third part is joined to the two former, which is a convex protuberance, more or less round, of about five or six fingers in breadth; the papilla and areola being situated near the middle of its convex surface. This is what is properly called *mamma*; and it may be termed the *body of the breast*, when compared with the other two parts. It increases with age, and is very large in women with child, and in those that give suck. In old age it

it decreaſes, and becomes flabby, loſing its natural conſiſtence and ſolidity.

Body of the mamma. The body of the mamma is partly glandular, and partly conſiſts of fat; or it is a gland of the conglomerate kind, ſurrounded on all ſides with cellular ſubſtance and fat. The glandular part is divided into little maſſes, ſeparated alſo by fat, and again ſubdivided into ſmall granulae, from which the lactiferous ducts ariſe: The cellulous pelliculae ſupport a great many blood-veſſels, lymphatics, and ſerous or lactiferous ducts, together with the ſmall glandular moleculae already mentioned; all of them being cloſely ſurrounded by two membranes continued from the pelliculae.

The innermoſt of theſe two membranes, which is in a manner the baſis of the body of the mamma, is thick, and almoſt flat, adhering to the muſculus pectoralis major. The ſecond, or external membrane, is thinner, forming a particular integument for the body of the mamma, more or leſs convex, and adhering cloſely to the ſkin.

The corpus adipoſum of the mamma, in particular, is a ſpongy cluſtre, more or leſs interlarded with fat, or a collection of membranous pelliculae, which, by the particular diſpoſition of their outer ſides, form a kind of membrane in ſhape of a bag, in which all the reſt of the corpus adipoſum is contained. The anterior or outer portion of this bag, or that which touches the ſkin, is very thin; but that ſide next the pectoralis major is thick.

Ductus lactiferi. The glandular body contains a white maſs, which is merely a collection of membranous ducts, narrow at their origin, broad in the middle, and which contract again as they approach the papilla, near which they were ſuppoſed by ſome to form a circle of communication; but, from the obſervations of the lateſt anatomiſts, the ducts have little or no communication with each other at this

place

place. They are named *ductus lactiferi*; and, in their courſe, are accompanied by a ligamentous elaſtic ſubſtance, which terminates with them in the nipple. Both this ſubſtance, and the ducts it contains, are capable of conſiderable extenſion and contraction; but, in their natural ſtate, they are moderately corrugated, ſo as to prevent an involuntary flow of milk, unleſs the diſtending force be very great, from the accumulation of too great a quantity.

Areola. The coloured circle or diſk, already mentioned, is formed by the ſkin; the inner ſurface of which ſuſtains a great number of ſmall glandular moleculae, of that kind which Morgagni calls *glandulae ſebaceae.* They appear very plainly all over the areola, even on the outſide, where they form little flat heights or eminences, at different diſtances, quite round the circle.

Theſe tubercles are perforated by ſmall holes, through which a kind of ſebaceous matter, more or leſs liquid, is poured out, to defend the areola and nipple. Sometimes one or more of the lactiferous ducts have been found to terminate upon the ſurface of the areola. Hence Morgagni was led to think that the glands there are of the lactiferous kind.

Papilla. The tubercle which lies in the centre of the areola, is termed *papilla*, or the *nipple.* It is of different ſizes in different ages and conſtitutions, and in the different conditions of females in particular. In women with child, or who give ſuck, it is large, or generally longer or higher than it is thick or broad; and, when it happens to be ſhort, it cauſes great uneaſineſs to the child.

The texture of the nipple is ſpongy, elaſtic, and liable to divers changes of conſiſtence, being ſometimes harder, ſometimes more flaccid. It ſeems to conſiſt chiefly of ligamentary faſciculi; the extremities of which form the baſis and apex of the nipple. Theſe faſciculi appear to be gently folded, or curled, during their whole length; and if, by drawing the

fibres out, these folds be destroyed, they return again as soon as that action ceases.

Between these spongy and elastic fasciculi, from twelve to fifteen or twenty particular tubes are lodged at small distances from each other, and all in the same direction. These tubes go to the basis of the papilla, and run through the apex by the same number of almost imperceptible holes or orifices; and as they are closely united to the elastic fasciculi, they are folded in the same manner with them.

The body of the papilla is covered by a thin cutaneous production, and by the epidermis. Its outer surface is uneven, being full of small tubercles and wrinkles; among which, those near the circumference of the nipple seem to have a transverse or annular disposition, which, however, is not uniform.

This disposition or direction seems to be owing to the elastic folds already mentioned: And, from this simple structure, it is easy to explain how infants, in sucking the nipple, and women in drawing the teats of cows, bring out the milk. For the excretory tubes, being wrinkled in the same manner as the fasciculi, do, by these wrinkles or folds, as by so many valves, hinder the milk contained in the ducts from flowing out; but, when the nipple is drawn and elongated, the tubes lose their folds, and the passage becomes straight. Besides this, when they are drawn with a considerable force, the whole body of the mamma is increased in length, and contracted in breadth, and thereby the milk is pressed into the open tubes; and thus, by barely pressing the body of the breast, the milk may be forced toward the nipple, and even through the tubes. Those who understand the principles of the air-pump will more readily conceive the manner in which the child draws out the milk.

Arteries, veins, nerves, &c. The arteries and veins, distributed through the mammae, are ramifications of the arteriae and

and venae mammariae; of which one kind comes from the ſubclaviae, and are named *mammariae internae*; the others, from the axillares, called *mammariae externae*.

Theſe veſſels communicate with each other, with thoſe near them, and with the vaſa epigaſtrica. The nerves come chiefly from the coſtales, and, by means of theſe, communicate with the great nervi ſympathetici. The mamma has numerous lymphatic veſſels, which Wriſberg obſerves run in two ſets: Moſt of theſe veſſels gradually collect into a great plexus, which go to the axillary glands; but others enter the thorax, through the interſtices of the ribs, near the ſternum, and communicate with the glands behind the mammary veſſels.

§ 2. *Pleura and Mediaſtinum.*

THE pleura is a membrane which adheres very cloſely to the inner ſurface of the ribs, ſternum, and muſculi intercoſtales, ſub-coſtales, and ſterno-coſtales, and to the convex ſide of the diaphragm. It is of a very firm texture, and is ſupplied with blood-veſſels and nerves, in all which it reſembles the peritonaeum; and likewiſe in its conſiſting of an inner true membranous lamina, and a cellular ſubſtance on the outſide.

Each ſide of the thorax has its particular pleura, entirely diſtinct from the other, and making, as it were, two great bladders, ſituated laterally with reſpect to each other in the great cavity of the breaſt, in ſuch a manner as to form a double ſeptum or partition running between the vertebrae and the ſternum, their other ſides adhering to the ribs and diaphragm.

This particular duplicature of the two pleurae is termed *mediaſtinum*. The two laminae of which it conſiſts are cloſely united together near the ſternum and vertebrae; but, in the middle,

middle, and toward the lower part of the foreſide, they are ſeparated by the pericardium and heart, as we ſhall ſee hereafter. A little more backward, they are parted in a tubular form by the oeſophagus, to which they ſerve as a covering; and in the moſt poſterior part a triangular ſpace is left between the vertebrae and the two pleurae from above downward, which is filled chiefly by the aorta.

Before the heart, from the pericardium to the ſternum, the two laminae adhere very cloſely; and there the mediaſtinum is tranſparent, except for a ſmall ſpace near the upper part, where the thymus is ſituated; ſo that in this place there is naturally no interſtice or particular cavity. The apparent ſeparation is owing entirely to the common method of raiſing the ſternum, as was plainly demonſtrated by Bartholinus, in his Treatiſe of the Diaphragm, publiſhed at Paris in 1676.

The mediaſtinum does not commonly terminate along the middle of the inſide of the ſternum, as was commonly ſuppoſed. Winſlow demonſtrated, in the year 1715, to the Royal Academy of Sciences, that from above downward, it inclines toward the left ſide; and that if, before the thorax is opened, a ſharp inſtrument be run through the middle of the ſternum, there will be almoſt the breadth of a finger between the inſtrument and the mediaſtinum, provided that the ſternum remain in its natural ſituation, and the cartilages of the ribs be cut at the diſtance of an inch from it on each ſide.

From all this we ſee, not only that the thorax is divided into two cavities entirely ſeparated from each other by a middle ſeptum, without any communication; but alſo that, by the obliquity of this partition, the right cavity is greater than the left; but there are exceptions to the above deſcriptions. Lieutaud ſays he has met with ſeveral ſubjects in which the mediaſtinum deſcended along the middle of the ſternum; and others, where it was inclined to the left ſide.

Sabatier

Sabatier obſerves that this is rare; but he has likewiſe met with ſeveral examples, where an inſtrument thruſt through the middle of the ſternum got into the left cavity of the thorax: And he has ſometimes ſeen the right lamina of the mediaſtinum fixed to the middle of the ſternum, while the left one was fixed oppoſite to the articulation with the cartilages of the ribs; a ſpace being left between the two, which was filled with cellular ſubſtance, intermixed with fat. From hence we may judge of the uncertainty of trepanning the ſternum, which the ancients have recommended in ſome caſes of abſceſſes, &c. between the layers of the mediaſtinum.

The pleura is connected to the membranous portion of the ſternum, ribs, and muſcles; to the diaphragm, pericardium, thymus, and veſſels; and, in a word, to whatever lies near its convex ſide.

The ſurface of the pleura turned to the cavities of the breaſt is continually moiſtened by a lymphatic ſeroſity which tranſudes through the pores of the membranous portion. This fluid is ſaid to be ſecreted by imperceptible glands; but the exiſtence of theſe glands has not been hitherto demonſtrated.

Arteries and veins. The arteries and veins of the pleura are chiefly ramifications of the intercoſtales; and theſe ramifications are exceedingly numerous, and for the moſt part very ſmall. The mammariae internae and diaphragmaticae likewiſe ſend branches hither, which communicate very frequently with thoſe that come from the intercoſtals.

The mediaſtinum has particular veſſels, called *arteriae* and *venae mediaſtinae*, which are commonly branches of the ſubclaviae. The mammariae internae ſend likewiſe ramifications to the fore-part of it, the diaphragmaticae to the lower part, and the intercoſtales and oeſophageae to the back-part.

Nerves. The nerves, which are few, are ramifications of the true intercoſtales. Near the vertebrae they communicate with

with the great ſympathetic nerves, and but very little with the eighth pair.

Uſe. The pleura ſerves in general for an inner integument to the cavity of the thorax. The mediaſtinum cuts off all communication between the two cavities, and hinders one lung from preſſing on the other when we lie on one ſide. It likewiſe forms receptacles for the heart, pericardium, oeſophagus, &c.; and it is continued over the lungs in the manner which ſhall be explained hereafter.

Before we leave the pleura, it muſt be obſerved, that it adheres firmly to the ribs. This adheſion keeps the pleura ſtretched, and hinders it from ſlipping or giving way. It likewiſe renders this membrane extremely ſenſible of the leaſt ſeparation cauſed by coagulated lymph or accumulated blood; the nervous filaments being likewiſe, in this caſe, very much compreſſed in inſpiration by the ſwelling of the intercoſtal muſcles.

§ 3. *Thymus.*

THE thymus is an oblong very ſoft glandular body, round on the upper part, and divided below into two or three great lobes, of which that toward the left ſide is the longeſt. In the foetus it is of a large ſize, leſs in children, and in aged perſons very little. In children it is of a white colour, ſometimes mixed with red; but, in an advanced age, its colour is generally dark.

The greateſt part of the thymus lies between the duplicature of the ſuperior and anterior portion of the mediaſtinum, and the great veſſels of the heart; from whence it reaches a little higher than the tops of the two pleurae, ſo that ſome part of it is out of the cavity of the thorax; and in the foetus and in children, it lies as much without as within the thorax, and is then compoſed of numerous lobules, each

incloſed

incloſed in a thin covering, and united together by cellular ſubſtance: Theſe are hollow within, and communicate together ſomewhat like the cells of the lungs; but they contain a milky fluid, which readily appears after an opening is made, but this fluid vaniſhes ſoon after birth. Among the various opinions about the uſe of this ſubſtance, ſome have thought it ſerved only to fill a part of the thorax of the foetus in the collapſed ſtate of the lungs, becauſe its ſize decreaſes after the lungs are dilated.

Its particular inward ſtructure and ſecretions are not as yet ſufficiently known, ſo as to enable us to determine its uſes; which, however, ſeem to be deſigned more for the foetus than for adults. It has veſſels belonging to it, called *arteriae* and *venae thymicae:* which are branches from the laryngaea inferior and mammaria interna.

§ 4. *Pericardium.*

The heart, with all the parts belonging to it, is contained in a membranous capſula, called *pericardium*, which is in ſome meaſure of a conical figure, and ſomewhat bigger than the heart; but the difference muſt be leſs during life when the heart is full of blood. It is not fixed to the baſis of the heart, but round the large veins above the auricles, before they ſend off the ramifications, and round the large arteries, before their diviſions.

The pericardium is made up of three laminae, the middle and chief of which is compoſed of very fine tendinous filaments, which are beſt ſeen in old perſons; they are cloſely interwoven, and croſs each other in different directions. The internal lamina ſeems to be a continuation of the outer coat of the heart, auricles, and great veſſels. The trunks of the aorta and pulmonary artery have one common coat, which contains them both as in a ſheath, and is lined on the inſide by

by a cellular ſubſtance, chiefly in that ſpace which lies between where the trunks are turned to each other, and the ſides of the ſheath. There is but a very ſmall portion of the inferior vena cava contained in the pericardium.

It is the middle lamina which chiefly forms the pericardium; and the figure of this bag is not ſimply conical, its apex or point being very round, and the baſis having a particular elongation which ſurrounds the great veſſels, as amply as the other portion ſurrounds the heart.

The pericardium is cloſely connected to the diaphragm, not to the apex, but exactly at that place which anſwers to the flat or lower ſide of the heart; and it is a very difficult matter to ſeparate it from the diaphragm in diſſection, the tendinous fibres of the one ſubſtance intermixing with thoſe of the other. This adhering portion is in ſome meaſure of a triangular ſhape, anſwering to that of the lower ſide of the heart; and the reſt of the bag lies upon the diaphragm, without any adheſion.

The external lamina, or common covering, as it may more properly be called, is formed by the duplicature of the mediaſtinum. It adheres to the proper bag of the pericardium by the intervention of the cellular ſubſtance in that duplicature, but leaves it where the pericardium adheres to the diaphragm, on the upper ſurface of which it is ſpread, as being a continuation of the pleura.

The internal lamina is perforated by an infinite number of very ſmall holes, through which a ſerous fluid continually tranſudes, in the ſame manner as in the peritoneum; there being no glands for this purpoſe, as ſome have ſuppoſed. The pericardium, at its fore part, receives arteries from the mammaria interna, and diaphragmatica: The lower part is ſupplied by the diaphragmatica, while the poſterior ſurface has branches from the ſubclavia, from the mammaria, and from the aorta, &c. The veins correſpond with the arteries, excepting

excepting ſome which go to the vena azygos. The nerves are chiefly from the eighth pair, and great ſympathetics. This fluid being gradually collected after death, makes what is called *aqua pericardii*, which is found in conſiderable quantities in opening dead bodies while they remain freſh. Sometimes it is of a reddiſh colour, which may be owing to a tranſudation of blood through the fine membrane of the auricles.

§ 5. *Of the Heart.*

Situation in general and conformation. THE heart is a muſcular body, ſituated in the cavity of the thorax, on the anterior part of the diaphragm, between the two laminae of the mediaſtinum. It is nearly of a conical figure, flatted on the ſides, round at the top, and oval at the baſis. Accordingly we conſider in the heart, the baſis; apex; two edges, the one right and the other left; and two ſides, one of which is generally flat and inferior, the other more convex and ſuperior.

Beſides the muſcular body, which chiefly forms what we call the *heart*, its baſis is accompanied by two appendices, called *auriculae*, and by large blood veſſels; of which hereafter: And all theſe are included in the pericardium.

The heart is hollow within, and divided by a ſeptum which runs between the edges into two cavities called *ventriculi*; one of which is thick and ſolid; the other thin and ſoft. This latter is generally termed the *right ventricle*, the other the *left ventricle*; though, in their natural ſituation, the right ventricle is placed more anteriorly than the left, as we ſhall ſee hereafter.

Each ventricle opens at the baſis by two orifices; one of which anſwers to the auricles, the other to the mouth of a large artery; and accordingly one of them may be termed

the *auricular orifice*, the other the *arterial orifice*. The right ventricle opens into the right auricle, and into the trunk of the pulmonary artery; the left into the left auricle, and into the great trunk of the aorta. At the edges of these orifices are found several moveable pelliculae, called *valves* by anatomists; of which some are turned inward toward the cavity of the ventricles, called *triglochines*, or *tricuspides*; others are turned toward the great vessels, called *semilunares*, or *sigmoidales*. The valvulae tricuspides of the left ventricle are likewise termed *mitrales*.

Ventriculi. The inner surface of the ventricles is very uneven, many eminences and cavities being observable in it. The most considerable eminences are thick fleshy productions, called *columnae*. To the extremities of these pillars are fastened several tendinous cords, the other ends of which are joined to the valvulae tricuspides. There are likewise other small short tendinous ropes along both edges of the septum between the ventricles. These small cords lie in an oblique transverse situation, and form a kind of net-work at different distances.

The cavities of the inner surface of the ventricles are small deep foffulae or lacunae placed very near each other, with small prominent interstices between them. The greatest part of these lacunae are orifices of the venal ducts, to be described hereafter.

Structure of the ventricles. The fleshy or muscular fibres, of which the heart is made up, are disposed in a very singular manner, especially those of the right or anterior ventricle; being either bent into arches or folded into angles.

The fibres which are folded into angles are longer than those which are only bent into arches. The middle of these arches, and the angles of the folds, are turned toward the apex of the heart, and the extremities of the fibres toward the basis. These fibres differ not only in length, but in their directions,

directions, which are very oblique in all, but much more ſo in the long or folded fibres than in the ſhort ones, which are ſimply bent.

It is commonly ſaid that this obliquity repreſents the figure 8; but the compariſon is very falſe, and can only agree to ſome bad figures drawn by perſons ignorant of the laws of perſpective.

All theſe fibres, regard being had to their different obliquity and length, are diſpoſed in ſuch a manner as that the longeſt form partly the moſt external ſtrata on the convex ſide of the heart, and partly the moſt internal on the concave ſide; the middle of the arches and the angles meeting obliquely and ſucceſſively to form the apex.

The fibres ſituated within theſe long ones grow gradually ſhorter and ſtraighter all the way to the baſis of the heart, where they are very ſhort, and very little incurvated. By this diſpoſition the ſides of the ventricles are very thin near the apex of the heart, and very thick toward the baſis.

Each ventricle is compoſed of its proper diſtinct fibres; but the left ventricle has many more than the right, its ſubſtance being conſiderably thicker. Where the two ventricles are joined, they form an impervious ſeptum which belongs equally to both. Oppoſite to this ſeptum a groove is ſeen on the outſide of the heart; one running longitudinally on its upper, the other on its under ſurface: In theſe grooves the great branches of the coronary arteries and veins are lodged.

There is this likewiſe peculiar to the left ventricle, that the fibres which form the innermoſt ſtratum of its concave ſide, form the outermoſt ſtratum of the whole convex ſide of the heart, which conſequently is common to both ventricles; ſo that, by carefully unravelling all the fibres of the heart, we find it to be made up of two bags contained in a third.

The

The anterior or right ventricle is ſomewhat larger than the poſterior or left, as was well obſerved by the ancients, and clearly demonſtrated by M. Helvetius. The left is a little longer than the right, and in ſome ſubjects they end exteriorly in a kind of double apex. But it appears from experiments, that the inequality between the parts of the right and thoſe of the left ſide of the heart are not ſo great during life as after death; for, in the hearts of animals killed by cutting acroſs the veſſels of the neck, and in thoſe of perſons who have died in battle from a wound in the vena cava or pulmonary artery, the inequality is leſs than we commonly find it. This was firſt obſerved by M. Vieuſſens profeſſor of anatomy at Altorf.

Sabatier has made numerous experiments on animals, the reſult of which is nearly the ſame with that mentioned above.

All the fibres are not directed the ſame way, though they are all more or leſs oblique: For ſome end toward the right, others toward the left, ſome forward, ſome backward, and others in the intermediate places; ſo that, in unravelling them, we find that they croſs each other gradually, ſometimes according to the length of the heart, and ſometimes according to its breadth.

The tubes which croſs each other tranſverſely are much more numerous than thoſe which croſs longitudinally; which ought to be taken notice of, that we may rectify the falſe notions that have been entertained concerning the motion of the heart, namely, that it is performed by a contortion or twiſting like that of a ſcrew, or that the heart is ſhortened in the time of contraction, and lengthened in dilatation.

The fibres which compoſe the inner or concave ſurface of the ventricles do not all reach to the baſis, ſome of them running into the cavity, and there forming the fleſhy columnae, to which the looſe floating portion of the tricuſpidal valves is faſtened by tendinous ropes.

Beſides

Beſides theſe fleſhy pillars, the internal fibres form a great many eminences and depreſſions, which not only render the inner ſurface of the ventricles uneven, but give it a great extent within a ſmall compaſs. Some of theſe depreſſions are the orifices of the venal ducts found in the ſubſtance of the ventricles, which have been already mentioned. The circumferences of the great openings at the baſis of the heart are tendinous, and may be looked upon as the common tendon of all the fleſhy fibres of which the ventricles are compoſed.

Valvulae. The valves at the orifices of the ventricles are of two kinds: One kind allows the blood to enter the heart, and hinders it from going out the ſame way; the other kind allows the blood to go out of the heart, but hinders it from returning. The valves of the firſt kind terminate the auriculae; and thoſe of the ſecond lie in the openings of the great arteries. The firſt are termed *ſemilunar* or *ſigmoidal valves*; the others, *triglochines*, *tricuſpidal*, or *mitral*.

The tricuſpidal valve of the right ventricle is of a circular form, and is fixed to the opening of the auricle, while the other end is attached to the internal ſurface of the ventricle. The circular membrane of the valve ſoon divides into many parts, three of which are more conſiderable than the reſt: and theſe have got the name of *tricuſpid valves*, though they are now generally conſidered as forming one. That which is next the mouth of the pulmonary artery is the largeſt, and ſome anatomiſts think that it prevents the blood from getting into the artery while the ventricle is filling. It has three triangular productions, very ſmooth and poliſhed on that ſide which is turned toward the auricle; but on the ſide next the cavity of the ventricle, they have ſeveral membranous and tendinous expanſions, and their edges are notched or indented. The valve of the auricular orifice of the left ventricle is of the ſame ſhape and ſtructure, but it is only

divided

divided into two parts; and, from ſome ſmall reſemblance to a mitre, has been named *mitralis*. That which is next the mouth of the aorta is the largeſt.

The ſemilunar valves are ſix in number, three belonging to each ventricle, ſituated at the mouths of the great arteries; and they may be properly enough named *valvulae arteriales*. Their concave ſides are turned toward the cavity of the arteries, and their convex ſides approach each other. In examining them with a microſcope, we find fleſhy fibres lying in the duplicature of the membranes of which they are compoſed.

They are truly ſemilunar, or in form of a creſcent, on that ſide by which they adhere; but their looſe edges are of a different figure, each of them repreſenting two ſmall creſcents; the two extremities of which meet at the middle of this edge, and there form a kind of ſmall papilla, firſt deſcribed by Arantius, and afterwards by Morgagni, and therefore named from them.

The aorta in general. The great artery that goes out from the left ventricle, is termed *aorta*. As it goes out, it turns a little toward the right, and then bends obliquely backward, to form what is called *aorta deſcendens*; which we ſhall have occaſion to mention again hereafter. At the beginning of the aorta, and behind the ſemilunar valves, three elevations are obſerved on the outſide: Theſe correſpond to an equal number of pits on the inſide, which, from the diſcoverer, have been called *ſinuſes of Valſalva*. Their uſe is not well known. From about the middle of the convex ſide of this curvature three great branches ariſe, which furniſh an infinite number of ramifications to the head and upper extremities of the body; as the deſcending aorta does in the ſame manner to the thorax, abdomen, and lower extremities.

The arteria pulmonaris in general. The trunk of the artery which goes out from the right ventricle is called *arteria pulmonaris*.

pulmonaris. This trunk, as it is naturally ſituated in the thorax, runs firſt of all directly upward for a ſmall ſpace; then divides laterally into two principal branches, one for each lung; that which goes to the right lung being the longeſt, for a reaſon that ſhall be given hereafter.

Auriculae. The auricles are muſcular bags ſituated at the baſis of the heart, and their capacities are in proportion to thoſe of their reſpective ventricles; one towards the right ventricle, the other towards the left, and joined together by an inner ſeptum and external communicating fibres, much in the ſame manner with the ventricles; one of them being named the *right auricle*, the other the *left*. They are very uneven on the inſide, but ſmoother on the outſide; and terminate in a narrow, flat, indented edge, repreſenting a cock's comb, or in ſome meaſure the ear of a dog. This properly gets the name of *auricle*, the larger and ſmooth part of the cavity being called *ſinus venoſus*; but, as the two parts make one general cavity, the name of *auricle* is commonly applied to the whole. They open into the orifices of each ventricle, called *auricular orifices*; and they are tendinous at their opening, in the ſame manner as the ventricles

The right auricle is larger than the left; and it joins the right ventricle by a common tendinous opening, as has been already obſerved. It has two other openings united into one, and formed by two large veins which meet and terminate there, almoſt in a direct line, called *vena cava ſuperior* and *inferior*. Highmore has deſcribed an eminence in form of a valve, placed between the mouths of the two venae cavae: This he ſuppoſed directs the blood from the veins into the auricle. Afterwards Lower deſcribed and delineated it; and other anatomiſts have called it *tuberculum Loweri*, till Morgagni denied its exiſtence in the human ſubject. At the mouth of the inferior cava we find a membrane in form of a creſcent, deſcribed by Euſtachius, and named from him. Its

convex

convex edge is fixed to the union of the vein and the right auricle, while its concave edge is turned upwards over the mouth of the vein. It is moſt complete in the foetus; but it is found likewiſe in perſons of advanced age, though it ſometimes, from uſe, has a reticular appearance. It is ſaid to prevent the blood in the auricle from returning into the cavæ; but it has a different uſe in the foetus. The notched edge of this auricle terminates obliquely in a kind of obtuſe point, which is a ſmall particular production of the great bag, and is turned toward the middle of the baſis of the heart.

The whole inner ſurface of the right auricle is uneven, by reaſon of a great number of prominent lines which run acroſs the ſides of it, and communicate with each other by ſmaller lines, which lie obliquely in the interſtices between the former. The lines of the firſt kind repreſent trunks; and thoſe of the other, ſmall branches in an oppoſite direction to each other. In the interſtices between theſe lines, the ſides of the auricle are very thin, and almoſt tranſparent, ſeeming to be formed merely by the external and internal coats of the auricle joined together, eſpecially near the point.

The left auricle is, in the human body, a kind of muſcular bag or reſervoir, of a conſiderable thickneſs, and unequally ſquare, into which the four venae pulmonares open, and which has a diſtinct appendix belonging to it, like a third ſmall auricle. This bag is very even on both ſurfaces, and is therefore called *ſinus venoſus*; but, to diſtinguiſh it from the one on the right ſide, it is called *ſinus venoſus ſiniſter*. However, the bag and appendix have but one common cavity; and therefore they may ſtill be both comprehended under the common name of the *left auricle*. In men, the ſmall portion may likewiſe be named *the appendix of the left auricle*; but, in other animals, the caſe is different.

This ſmall portion or appendix of the left auricle is of a different ſtructure from that of the bag or large portion. Exteriorly,

teriorly, it reſembles a ſmall oblong bag, bent different ways, and indented quite round the edges. Interiorly, it is like the inſide of the right auricle. The whole common cavity of the left auricle is ſmaller in an adult ſubject than that of the right; and the fleſhy fibres of the left auricle croſs each other obliquely, in ſtrata differently diſpoſed.

Arteriae et venae coronariae. Beſides the great common veſſels, the heart has veſſels peculiar to itſelf, called *the coronary arteries* and *veins*, becauſe they in ſome meaſure crown the baſis of the heart. The coronary arteries, which are two in number, go out from the beginning of the aorta, and afterwards ſpread themſelves round the baſis of the heart, to the ſubſtance of which they ſend numerous ramifications.

Vieuſſens believed that ſome of the branches of the coronary artery opened into the cavities of the ventricles and auricles; for, by throwing a fine injection into theſe arteries, he found it run out on all ſides of the right ventricle and auricle. Thebeſius being nearly of the ſame opinion, endeavoured to prove that there were veins which carried part of the blood from the coronary arteries immediately into the cavities of the heart; and theſe have therefore got the name of *veins of Thebeſius*, though he is not the firſt diſcoverer. Winſlow, Haller, and ſeveral others, deſcribe ſuch veins; but Duverney, after injecting the heart of an elephant, doubts of their exiſtence. Senac, who has paid much attention to this ſubject, denies it altogether; and Sabatier coincides with him in opinion.

There are ſeldom more than two arteries; of which one lies toward the right, the other toward the left of the anterior third part of the circumference of the aorta. The right coronary artery runs in between the baſis and right auricle, all the way to the flat ſide of the heart, and ſo goes half way round. The left artery has a like courſe between the baſis and left auricle; and, before it runs on the baſis, it ſends off a capital branch, which runs in between the two ventricles.

Another principal branch goes off from the union of the two arteries on the flat ſide of the heart; which running to the apex, there joins the other branch.

The coronary veins are diſtributed exteriorly, much in the ſame manner. The largeſt opens into the poſterior inferior part of the right auricle, by an orifice which is furniſhed with a valve firſt deſcribed by Euſtachius. Beſides the coronary veins, the heart has other anterior veins, which have been called by Vieuſſens *venae innóminatae*. Some of them go into the right auricle, others end in the right ventricle; and there are other veins ſtill ſmaller, which are found in the ſubſtance of the heart, and which terminate in the right ſinus and auricle.

The nerves of the heart, are from the par vagum and great ſympathetics: Theſe form the cardiac plexus, which ſends off branches to the pericardium, to the roots of the great veſſels, and are ſpent at laſt on the different parts of the heart.

Particular ſituation of the heart. The heart lies almoſt tranſverſely on the diaphragm, the greateſt part of it being in the left cavity of the thorax, and the apex being turned toward the bony extremity of the ſixth true rib. The baſis is toward the right cavity; and both auricles, eſpecially the right, reſt on the diaphragm; but the ſituation of the heart during life changes a little, according to the ſtate of reſpiration, and to the poſition of the body.

The origin or baſis of the pulmonary artery is, in this natural ſituation, the higheſt part of the heart on the foreſide; and the trunk of this artery lies in a perpendicular plane, which may be conceived to paſs between the ſternum and the ſpina dorſi. Therefore ſome part of the baſis of the heart is in the right cavity of the thorax; and the reſt, all the way to the apex, is in the left cavity; and it is for this reaſon that the mediaſtinum is turned toward that ſide.

According to this true and natural ſituation of the heart, the parts commonly ſaid to be on the right ſide are rather anterior,

anterior, and thoſe on the left ſide poſterior; and that ſide of the heart which is thought to be the foreſide is naturally the upper ſide, and the backſide conſequently the lower ſide.

The lower ſide is very flat, lying wholly on the diaphragm; but the upper ſide is a little convex through its whole length, in the direction of the ſeptum between the ventricles. And it may be proper here to remark, that, though commonly received terms of art may be ſtill retained, yet it is neceſſary to prevent their communicating falſe ideas to thoſe who have not had an opportunity of making obſervations themſelves, or of being inſtructed by others.

Uſes in general. The heart, and the parts belonging to it, are the principal inſtruments of the circulation of the blood. The two ventricles ought to be conſidered as two ſyringes, ſo cloſely joined together as to make but one body, and furniſhed with ſuckers placed in contrary directions to each other, ſo that by drawing one of them a fluid is let in, and forced out again by the other.

The heart is compoſed of a ſubſtance capable of contraction and dilatation. When the fleſhy fibres of the ventricles are contracted, the two cavities are leſſened in an equal and direct manner, not by any contortion or twiſting, as the falſe reſemblance of the fibres to a figure of 8 has made anatomiſts imagine. For, if we conſider attentively in how many different directions, and in how many places, theſe fibres croſs each other, as has been already obſerved, we muſt ſee clearly that the whole ſtructure tends to make an even, direct, and uniform contraction, more according to the breadth or thickneſs, than according to the length of the heart; becauſe the number of fibres ſituated tranſverſely is much greater than the number of longitudinal fibres.

The fleſhy fibres thus contracted do the office of ſuckers, by preſſing upon the blood contained in the ventricles; which blood being thus forced toward the baſis of the heart, preſſes the tricuſpidal valves againſt each other, opens the ſemilunares,

milunares, and ruſhes with impetuoſity through the arteries and their ramifications, as through ſo many elaſtic tubes.

Syſtole. The blood thus puſhed out by the contraction of the ventricles, and afterwards preſſed by the elaſtic arteries, enters the capillary veſſels, and is from thence forced to return by the veins to the auricles, which, like retirements, porches, or antichambers, receive and lodge the blood returned by the veins during the time of a new contraction. This contraction of the heart is by anatomiſts termed *ſyſtole.*

Diaſtole. The contraction or ſyſtole of the ventricles ceaſes immediately, by the relaxation of their fleſhy fibres; and, in that time, the auricles which contain the venal blood, being contracted, force the blood through the tricuſpidal valves into the ventricles, the ſides of which are thereby dilated, and their cavities enlarged. This dilatation is termed *diaſtole.*

Circulation. In this manner does the heart, by the alternate ſyſtole and diaſtole of its ventricles and auricles, puſh the blood through the arteries to all the parts of the body, and receive it again by the veins. This is called the *circulation of the blood*, which is carried on in three different manners.

The firſt and moſt univerſal kind of circulation is that by which almoſt all the arteries of the body are filled by the ſyſtole of the heart, and the greateſt part of the veins evacuated by the diaſtole.

The ſecond kind of circulation, oppoſite to the firſt, is through the coronary veſſels of the heart, the arteries of which are filled with blood during the diaſtole of the ventricles, and the veins emptied during the ſyſtole.

The third kind of circulation is that of the left ventricle of the heart; through the venal ducts of which a ſmall quantity of blood paſſes, without going through the lungs, which is the courſe of all the remaining maſs of blood.

Beſides theſe three different kinds of circulation, there are ſome peculiarities in the courſe of the blood, which may be looked

looked upon as particular circulations. Such is the paſſage of the blood through the liver, corpora cavernoſa of the parts of generation, and through the cavernous ſinuſes of the dura mater.

Nature hath given a heart to moſt animals, even to many inſects and worms; to others ſhe hath denied it; and theſe are the moſt ſimple of all animals, and are irritable throughout their whole body; they are alſo ſometimes very large, as we ſee in many ſpecies of the hydra. Thoſe animals which have no hearts have alſo no veſſels.

The blood of the two venae cavae is propelled by a muſcular force, in either vein, into the right auricle. Theſe veins, while they lie within the thorax, are endowed with ſtrong and irritable muſcular fibres, by whoſe contraction the blood is driven into the neighbouring auricle.

In like manner, the auricle, being irritated, is contracted on all ſides. Firſt, by a conſtriction of its muſcular fibres, the anterior ſemicylinder of the auricle is reduced to a plane; while the ſame fibres, by their contraction, bring back the middle arch towards the anterior extremity or beginning of the heart, and likewiſe towards its poſterior extremity or ſinus; afterwards the appendix of the auricle deſcends, and is contracted tranſverſely, while the lower part aſcends; and thus the auricle becomes ſhorter: And, laſtly, the left edge turns evidently to the right, and the right edge a little to the left; and thus the auricle is rendered narrower. The blood of both cavae muſt neceſſarily, therefore, be driven through the open valves of the right ventricle of the heart: becauſe the blood is hindered from returning again into the lower cava, by the contraction of the auricle, by the reſiſtance of the ſucceeding blood from the abdomen, and by means of the *Euſtachian valve*; and is hindered from aſcending, both by the motion and weight of the conſequent blood. It is driven back,

back, however, on both ſides, if there happens to be any obſtacle in the lungs.

The uſe of the valvulae tricuſpides is ſufficiently evident; for the right auricle being contracted, the blood is forced through the auricular orifice, and, like a wedge, ſeparates the pendulous portions of the valves, and preſſes them to the ſides of the heart; while the uppermoſt valve ſhuts the pulmonary artery, leſt the blood, by the weak impulſe of the auricle, ſhould flow into that artery: The blood thus received, and confined within the right ventricle of the heart, is, by its ſtrong contraction, powerfully expelled into the artery.

The ſenſible fleſh of the heart, being irritated by the quantity and weight of this warm blood, is thereby ſolicited to a contraction: For that the heart, being irritated, will contract itſelf in a perſon dying, or even lately dead, is proved by injections of water, and inflations of air, whereby the heart, then quieſcent, is recalled to its motion.

The fibres of the heart, like other muſcles, are furniſhed with nerves of various origin, in great abundance.

That theſe nerves conduce powerfully to move the heart is highly probable, from a conſideration of the common nature of muſcles; from the increaſe which follows in the heart's motion by irritating the eighth pair of nerves, either at the brain or the ſpinal medulla; and from the langour that enſues upon tying theſe nerves, which proves fatal, either ſuddenly or within a few days, even though the ligature be made only on a few of them; for the intercoſtal, and eſpecially thoſe from the ganglion of the upper thoracic, cannot be tied.

But that there are ſtill other cauſes, beſides that of the nerves, conducing to the motion of the heart, we are perſuaded from obſerving its motion undiſturbed by the irritation of all the nerves in the living animal; from its remaining after the greateſt wounds of the head, and even of the cerebellum

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and medulla ſpinalis; likewiſe, from its motion when torn out of the breaſt; chiefly in thoſe animals whoſe lungs, being impermeable, make no reſiſtance to the heart's motion; for the motion of the heart is obſerved to be very vigorous in the foetus, before the brain is well formed, and likewiſe in animals wanting the head. And all our experiments agree in this, that the quieſcent heart, in dead or dying animals, when irritated by heat, vapours, poiſons, and eſpecially impelled flatus, watery liquors, wax, or blood, or on receiving an electric ſpark, immediately contracts itſelf, putting all its fibres into a rapid motion, by a force ſometimes common to the whole heart, and ſometimes affecting only a particular part of it.

There reſides in the heart a kind of deſire to be ſtimulated, ſo that, even when it is almoſt dead, wrinkles radiating from a point appear in many places, and trembling motions are propagated through different parts of its ſurface. Again, the heart, when torn out and cold, on being pricked, inflated, or irritated, contracts itſelf; and its fibres, when diſſected, corrugate themſelves orbicularly, when there is neither nerve nor artery to bring it ſupplies of any kind. This irritability is greater, and remains longer in the heart, than in any other part of the body; for, by ſtimulating the heart, its motion may be renewed at a time when that of no other muſcle can. The heart of the foetus is moſt irritable, as well as larger in proportion, than in adults, and moſt tenacious of its motion, even in the cold. The motion of the heart appears to be innate, coming neither from the brain nor the ſoul; it remains even when the heart is removed from the body, and it can neither be increaſed nor retarded by the will.

It is, therefore evident, that the ſtimulus occaſioned by the venous blood driven into the heart, cauſes it to contract. This contraction is convulſive, made with great celerity, and a manifeſt corrugation of the fibres. The whole heart, in

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the contraction, becomes ſhorter, thicker, and harder, ſo that the left ventricle is drawn ſomewhat towards the ſeptum of the heart, and the right one much more. The baſe alſo advances towards the apex; but the apex more evidently towards the baſis *. Even the ſeptum of the heart is rendered ſhorter, and draws itſelf towards the baſis. By this action, the fleſhy parts of the heart ſwell inwardly, and compreſs the blood. Of this fact we may be convinced, by thruſting the finger into the ventricle of the heart in an animal newly killed. That the heart is accurately enough emptied in this action, appears from the event; from the evident paleneſs of animals whoſe heart is white, as frogs and chickens; and from the internal ſurface being full of eminences, which exactly anſwer to oppoſite cavities, and to the thick reticular arms or columns interrupted by ſinuſes. The apex of the heart, being contracted a little like a hook, ſtrikes againſt that part of the pericardium next the thorax. Forwards, there is alſo a pulſation from the left venal ſinus, which is at that time filled. In exſpiration, the heart ſtrikes violently upwards and forwards. The truth of both theſe we know by experiment.

The blood, which is preſſed by the contracted heart, endeavours to eſcape in all directions; it is driven from the muſcular ſides, towards the axis of the ventricle, and that part of it which is contained between the ſides of the ventricle and the annulus of the auricular orifice, puſhes the annulus within the auricle, and by this action upon the whole circumference of the annulus, it becomes extended. A ſmall quantity of blood is indeed returned into the auricle before the

* This Dr Haller has often obſerved with the greateſt certainty in diſſecting brute animals; ſo that thoſe learned gentlemen muſt have ſome way or other been deceived, who have aſſerted that the heart is elongated during its contraction.

the preſſure becomes ſufficient to cloſe the tricuſpid valves. When theſe valves are ſhut, the violent preſſure of the blood againſt them might conſiderably injure them, or even puſh them back into the auricle; but to prevent any accident of that kind, their muſcular columns, which contract with the heart, keep their edges firmly united.

The blood being impelled from the ſides towards the axis of the contracting heart, endeavours to eſcape in that direction, and, by ruſhing like a wedge between the valves, preſſes their looſe edges againſt the ſides of the pulmonary artery, ſo as to run freely out of the heart. The truth of this appears from the fabric of the parts, from injections, and from ligatures, which, by obſtructing the lungs, will not ſuffer the cavities in the right ſide of the heart to be emptied.

The blood now received into the pulmonary artery, circulates through the lungs. That the blood goes directly from the arteries into the pulmonary veins, appears evidently from their ſtructure; from a ligature, which, confining the blood between the heart and lungs, cauſes an aneuriſmatic dilatation of the artery; from polypuſes, by which the mouth of the pulmonary artery being obſtructed, the right cavities of the heart become enlarged, and at length burſt, while the left remain empty; from injections, for water, iſinglaſs, and milk, are very eaſy forced from the pulmonary artery into the vein, and from thence into the left cavity of the heart. And laſtly, the direct anaſtomoſes, or final openings of the arteries into the veins in the lungs, may be ſeen by microſcopes, in frogs, &c.

The blood which has once entered the pulmonary artery cannot return to the heart; becauſe its valves are of ſuch dimenſions, that when diſtended, they perfectly ſhut up the opening at the heart; and they are ſo ſtrong that they reſiſt a much greater force than the contraction of the pulmonary artery. Sometimes, however, from a greater contractile

force of the artery, they grow ſomewhat callous; or, from a laceration of their outer membrane, a bony matter is poured in between the duplicature of the valves. When the blood, by the contraction of the artery, returns towards the heart, it meets and enters the open concavities of the valves, which are by that means expanded, and the mouth of the artery is completely ſhut. Any opening that might be left, is precluded by the ſmall callous bodies in the middle of the valves.

The *pulmonary veins*, of which we ſhall ſay more hereafter, run into larger branches, which at laſt terminate in four (ſeldom two, and ſtill more rarely five) trunks; to which it has been cuſtomary to affix a name in the ſingular, by calling them the *pulmonary vein*. Theſe enter the cavity of the pericardium, from whence they receive an external covering, and are then inſerted into the corners of the left or poſterior ſinus, which is ſometimes likewiſe called the *pulmonary ſinus*. In this courſe the upper veins deſcend, and the lower ones aſcend. That theſe veins bring their blood towards the heart, in the ſame direction with the ſinus into which they open, is proved by a ligature, which cauſes a turgeſcence or ſwelling, from the blood being retained between the ligature and the lungs.

In this left ſinus the blood waits for the heart's relaxation, when it is driven into the left ventricle, in the ſame manner as the right auricle impelled its blood into the right ventricle.

From what has been ſaid then, it appears that the ſame blood is now arrived into the left ventricle of the heart, which was a little before ſent from the venae cavae into the right auricle. This courſe of the blood, from one ſide of the heart to the other, through the lungs, is called the *pulmonary* or *leſſer circulation*, and was known to many of the ancients. It is proved by the increaſed bulk of the pulmonary

nary veins on the left ſide, and likewiſe of the right cavities of the heart, from the entrance into the left ventricle being obſtructed.

The *left*, or poſterior and upper *ventricle* of the heart, which is always firſt formed, and in a great number of animals the only one, make that part of the heart which we before called its convex ſuperior ſide. It is ſomewhat narrower, a little longer, rounder, and generally of a leſs capacity, in Dr Haller's opinion, than the right ventricle; for its contents are about two ounces, while thoſe of the right amount to three. Its internal fabric is reticular, but more nicely wrought than in the right ventricle, and within the mouth of the artery it is ſmooth; but its force is conſiderably greater, as the muſcular fleſh that ſurrounds it is much thicker, and almoſt three times as ſtrong. The ſeptum of the heart belongs moſtly to the left, but ſome part of it alſo to the right ventricle: The whole of it is reticulated, but ſolid, and incapable of ſuffering any injected liquid to paſs from one ventricle to another.

Again, this left ventricle being excited to motion by the impelled blood, from the ſame irritable nature already mentioned, contracts, and drives its contained blood with a violent motion in the direction of its axis, the tip or cone of the heart being at the ſame time drawn nearer to its baſis. And ſince the apparatus of the mitral valves is here the ſame as in the tricuſpids, the blood now expanding the ring from whence they ariſe, removes that valve which lay againſt the mouth of the aorta, and opens a way for itſelf to the artery. This is proved by ocular demonſtration in living animals, where the left ventricle ſwells upon ſhutting the paſſage into the aorta.

The *ſemilunar valves of the aorta* differ little from thoſe of the pulmonary artery: Only, as the opening is here greater, ſo the valves are proportionally larger and ſtronger, and are

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not ſo often found to want thoſe callous round bodies in the middle. The fibres, too, of the valves, both tranſverſe and aſcending, are here ſomewhat more conſpicuous.

After the contraction of the heart follows its relaxation or diaſtole, in which it becomes empty, lax, and ſoft, recovers its former length, the ventricles recede from the ſeptum, and the baſis from the apex. But, while it is in this ſtate, the blood in the auricles having been, as it were, in a ſtate of expectation, ruſhes through the openings of the valves of the veins, dilates the oppoſite ſides of the heart, and increaſes all its dimenſions. After the auricles have freed themſelves of the blood they contained, they are in like manner relaxed, and their oppoſite ſides remove from each other. The blood then collected in the venae cavae and pulmonary veins, fills the auricles by the contraction of the veins; renders them long, broad, and thick, like the ventricles; and even diſtends and fills the dentated proceſſes of the creſted margin.

Theſe motions of the right and left auricle, with the right and left ventricle, are not performed in that ſucceſſion in which, for the ſake of method, we have here deſcribed them; for both the auricles are contracted, while both the ventricles are relaxed: So that the contraction of the auricles precedes the contraction of the ventricles. This fact is aſcertained by experiments on dying animals, and on animals with cold blood. Thoſe who have inadvertently taught otherwiſe, have not taken the advantage of making a ſufficient number of experiments on living animals. That the auricle, near death, makes frequent palpitations before the ventricle of the heart performs one contraction, is certainly true. The auricle, with its ſinus, forms one cavity; and both are filled and both emptied in the ſame inſtant.

It may be aſked, Why the heart is not wearied, or becomes painful, by ſo rapid, long continued, uninterrupted, and violent a motion? The heart contracts, in a healthy perſon, about

about 5000 times in an hour, and never ceaſes its alternate contractions and dilatations from the firſt beginning of its exiſtence till death? Why, then, does it not, like other muſcles, become tired, in a very few hours, by ſuch violent motions? How is its ſtrength preſerved? Different anſwers have been given to theſe queſtions by different profeſſors, founded either on a compreſſure of the cardiac nerves between the large arteries, or on an alternate repletion of the coronary arteries and cavities of the heart, &c. But to Dr Haller the ſimplicity of nature in this matter is very conſpicuous. When the auricle is relaxed, it is directly filled by the muſcular force of the continuous great vein; and the heart contracts when it is irritated by the blood driven into it from the auricle, and thus empties itſelf of the blood. Being freed from the ſtimulus, it immediately reſts or relaxes itſelf. The heart being now relaxed, the auricle is, in like manner, irritated by its contained blood, and, by contracting, fills the heart again; while the inceſſant actions of the heart and arteries continually urge new blood into the right ſinus and auricle. That this is the true cauſe of the heart's motions is proved from actual experiment and obſervation. The ſucceſſive repletions and contractions made in the great vein, auricle, ventricle, and artery, are plainly and eaſily ſeen in a weak or expiring animal; but, more eſpecially, and more evidently, in thoſe animals which have but one ventricle in the heart, as the tortoiſe, frog, ſnake, fiſhes; and in the chick hatching in the egg, which, inſtead of a heart, has only one crooked canal. Beſides, it is confirmed from the inertia of the heart, produced by tying the veins; and, from the return of its motion, when the ligatures are unlooſed; provided theſe phenomena are ſufficiently valid; but it is more unequivocally corroborated by injection, and by the experiment of inflating a frog's heart with a ſmall bubble of air, which we ſee alternately paſs from the ventricle to the auricle and back again for many hours.

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The left ventricle firſt ceaſes its motion; then the auricle of that ſide; then the right ventricle; after that the right auricle; and, laſt of all, the pulmonary veins and venae cavae. Whatever motion is in the venae cavae, ought to be attributed to the auricle repelling the blood into both theſe veins, and which the heart, when dead, is not capable of receiving.

Dr Haller believes that nothing more is requiſite to produce the heart's motion than a continual ſtimulus applied to a very irritable part. For, on the approach of death, the coldneſs of the limbs contracts the veins, and drives the blood to the heart; the lungs, being impermeable for want of reſpiration, tranſmit no blood to the cavities of the left ſide; and the heart, after it is thoroughly emptied, remains at reſt.

The velocity of the blood, at its entrance into the aorta, and the force with which it is expelled from the heart, have been ſubjects of much controverſy; and different anatomiſts have computed them differently. To determine the velocity, modern writers proceed on the following data. They ſuppoſe that two ounces are expelled by each ſyſtole, that each ſyſtole is the third part of the whole pulſation, and is performed in healthy perſons in $\frac{1}{225}$ part of a minute, that the area of the aorta is 0.4187, of an inch, and that two ounces of blood occupy a ſpace of 3.318 cubic inches; or, in other words, that a cylinder of blood, whoſe ſolidity is 3.318 inches, and baſe 0.4187, is expelled by the heart in $\frac{1}{225}$th part of a minute. Since the ſolidity of a cylinder is the product of the area of its baſe into the length, its length will be equal to the ſolidity divided by the baſe; therefore, in this caſe, 3.318 divided by .4187 gives 7.9245 for the length which the blood runs in $\frac{1}{225}$ of a minute; that is, 148 feet 7 inches in a minute. To determine the force, they ſuppoſe that the perpendicular jet from the heart is 7 feet 6 inches, and the area of the ſurface of the ventricle is 15 inches; theſe two numbers multiplied give 1350 cubical inches, or 51 pounds of blood againſt which

which the heart acts. The heart, therefore, ſends a weight of 51 pounds, with the velocity of 149 feet in a minute.

The above computation may perhaps be innacurate, both from the omiſſion of ſome circumſtances that ought to have been taken into the account, and from the inaccuracy of the data; but that the heart appears to be a very powerful machine is evident from the great difficulty we have in filling all the red blood-veſſels by anatomical injections, and the utter impoſſibility of filling all the ſmaller ones: yet the heart, we ſee, not only gradually diſtends all the larger, the ſmaller, and even the leaſt veſſels, with blood, but alſo drives it forward through them with a conſiderable velocity. Even in the leaſt arteries, the blood is urged forward by the heart with ſuch a force as to make the alternate motions of that powerful muſcle perceptible; even in ſuch animals as are ſcarcely viſible to the naked eye, and in the ſmall embryos of inſects. And, from ſome of the leaſt arteries, I have ſeen the blood ſtart ſeveral feet, the jet deſcribing a parabola, whoſe height was four feet, and the amplitude of projection ſeven; and ſome anatomiſts aſſert that they have ſeen the blood aſcend from the aorta to the height of twelve feet.

Moreover, that we may make a juſt eſtimate of the heart's force in living animals, we muſt conſider what great reſiſtances that complex muſcle overcomes: We muſt compute the enormous weight of the whole maſs of blood; a maſs perhaps of fifty pounds and upwards: For all the quantity of fluids, once ſtagnant in a perſon lately drowned or fainting away, are eaſily put into their former motion by the heart alone. We muſt alſo conſider the great decreaſe of the blood's velocity, ariſing from the greater capacity of the dividing branches; and yet, even in the leaſt veſſels, its velocity is very conſiderable, as appears by the Sanctorian perſpiration ſeen to fly rapidly

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off like ſmoke, and by the quick motion of the blood ſeen, by the help of microſcopes, in fiſhes tails. Frictions in every machine always conſumes the greateſt part of the moving forces; and theſe frictions will doubtleſs be very large in the human body, whoſe blood and juices are extremely viſcid, and whoſe veſſels are ſo ſmall as ſcarcely to allow more than a ſingle globule to paſs at a time, and even that not without changing its figure. All theſe reſiſtances being conſidered, we may without doubt conclude that the force of the heart muſt be extremely great, in order to preſerve the motion ſo ſtrong as we perceive it in the leaſt arteries. Another argument of the heart's force is, that aneuriſms and arteries are burſt, and very great weights, as well as the body itſelf, raiſed by the force of the heart's ſyſtole.

The blood, being driven into the aorta, ruſhes firſt of all into the coronary arteries, by which the heart is ſupplied with blood. Theſe arteries are for the moſt part two; the right goes off between the aorta and pulmonary artery, and the upper and left one between the left auricle and the aorta. All the external arteries are ſurrounded with much fat; but their cavity is more intercepted with valves than that of other arteries. Theſe arteries communicate, by moſculations of the ſmall branches, every where about the ſeptum and tip of the heart; but they no where make a complete ring round the heart. They terminate in a twofold manner.

The firſt termination of them is into the coronary veins, whoſe branches run in company with thoſe of the arteries, but their trunks run in a different courſe.

Some authors ſuppoſe that the coronary arteries are filled with blood, not by the contracting of the heart, but of the aorta; and the arguments by which they ſupport their hypotheſis are, the retrograde angle at which the coronaries go off, the paleneſs of the contracted heart, and the valves

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of the aorta covering the mouths of the coronary arteries. But the two laſt of theſe arguments are contradicted by experience; and the firſt can only impede or leſſen, and not intercept, the flux into the heart: For the injections of air or mercury into all the ſeminal and biliary veſſels, demonſtrate that the large retrograde angles, which the veſſels often make there, do not hinder the fluids from taking their natural courſe, though they retard them. But a proof, ſtill more evident, is, that the coronary artery beats at the ſame time with all the other arteries in the body, and the blood ſtarting from it makes a higher ſaltus at the time when the heart is contracting.

§ 6. *Of the Nature of the Blood and Juices of the Human Body.*

THE liquor which is contained in the arteries and their correſponding veins, is known by the general name of *blood*: It appears homogeneous, is coagulable, and of a red colour; it is redder in ſtrong and well fed animals, and generally yellow in ſuch as are weak and ſtarved. White ſtreaks ſometimes appear in it, in conſequence of the chyle. But from various experiments it is certain, that this animal liquor contains very different ingredients.

That fire is contained in the blood may be proved from its heat, which, in human blood, and that of ſome other animals, is from 92 to 100 degrees of Fahrenheit's thermometer, which is more than the mean degree of atmoſpherical heat, but leſs than the greateſt. Dr Wriſberg ſays, that daily experience ſhews that it differs in man, according to age, temperament, ſtate of mind, motion or reſt of body, climate, weather, kind of life, meat and drink, health, and the various ſpecies and violence of diſeaſe. It is alſo certain that the degrees of heat in the body increaſes a little from an augmentation of heat in the atmoſphere; but it does not

riſe to the greateſt pitch of ſummer heat. We can live in a much greater heat than the heat of the warmeſt ſummer, as is proved by perſons employed in ſugar-houſes, melting-furnaces, by mowers, and the uſe of baths and ſtoves in Finland and Ruſſia; and alſo by the late experiments of Fordyce, Blagden, Hunter, and Dobſon. The heat of the blood is ſometimes ſo diminiſhed in an intenſe cold, that in a perſon froſt bitten, but not dead, a thermometer applied to the mouth, arm-pits, groins, and even the vagina, would not riſe above 76° of Fahrenheit. Is the matter of heat in the blood alone? This is ſufficiently probable from phenomena; for the heat of the body is diminiſhed by hemorrhagy, or when the blood is intercepted by ligature and compreſſion from reaching the joints, and is reſtored when the blood returns. I muſt obſerve, however, that my experiments upon living animals, particularly upon ſwine, did not diſcover ſo great a difference as might have been expected, between the heat of the heart, arteries, veins, brain, ſtomach, inteſtines, tunica vaginalis, and even the interſtices of the cellular texture in the muſcles. Again, a kind of volatile vapour or exhalation continually flies off from the warm blood, which has a ſort of foetid ſmell, intermediate between that of the ſweat and urine. This vapour, after collection and condenſation in convenient veſſels, partakes of an aqueous nature, with ſomewhat of an alkaline quality.

After this vapour has diſſipated, the blood of a healthy perſon ſpontaneouſly congeals into a ſciſſile, trembling maſs, eſpecially in a heat of about 150 degrees, and ſooner in feveriſh perſons than in ſuch as are in health. It ſometimes coagulates in the veins of a living perſon, and is found clotted in wounds of the arteries. But even within the veſſels of a living perſon, and in one dying of a fever, the blood has been ſeen, by the violence of that diſtemper, changed into a concreted tremulous jelly throughout all the veins. The

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principal part of this coagulated mass is the *crassamentum* or *cruor*, which has the red colour peculiar to itself, and gives it to the other parts of the blood. This, if it be not kept fluid by the attrition of a vital circulation, or some similar concussion, runs into a confused compact, but soft mass, like liver, merely by rest and a moderate degree of cold; as it also does by the addition of alcohol, by mineral acids, or by a heat of 150 degrees. It is either as a fluid or a solid, specifically heavier than water by near an eleventh part; and, when freed from its water, it is inflammable. In a mass of healthy blood, one half or upwards is red cruor; and, in strong laborious people, the serum makes only a third part; and is still more diminished in fevers, often to a fourth or fifth part of the mass.

The white, yellowish, watery part of the blood, commonly called the serum, which separates from this coagulum, transuding, as it were, through its pores, forms a fluid in which the coagulum sinks; this again seems, though it really is not so, a homogeneous liquor; it is, in general, one thirty-eighth part heavier than water, and almost a twelfth part lighter than the red globular mass of crassamentum: By a heat of 150 degrees, or by mixture of mineral acids or alcohol, and by a concussive motion, it is coagulable into a much harder mass than the red cruor, and forms first an indissoluble glue, then a flesh-like membrane, and at length shrinks up to a horn-like substance or friable gum. The pleuritic crusts or skins, polypuses, and artificial membranes, are formed from this part of the blood. Besides this coagulable albumen, the serum contains a very considerable portion of simple water, and some mucus, less capable of being drawn into threads than the red cruor; nor at the same time coagulable, like the albumen, by heat and acids. Hewson has discovered a second kind of lymph, which Krausius has also allowed.

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By putrefaction alone, or the diſſolving power of the air, in a heat equal to 96 degrees, the whole maſs, but eſpecially the ſerum, diſſolves or melts into a foetid liquor; firſt the ſerum, and then the cruor more ſlowly, till at length the whole maſs, both of ſerum and cruor, is turned into a volatile and foetid exhalation, leaving very few foeces behind. The blood being a little diſſolved by the beginning putrefaction, becomes foetid; with the foetor it aſſumes an alkaline nature, and effervesces with acids. This property it afterwards loſes, the alkaline ſalt being deſtroyed by the complete putrefaction. The putrid blood cannot by any art be inſpiſſated, and it is very difficult to reſolve it, after it has been coagulated by ſpirit of wine. By too ſevere exerciſes, heat, and malignant diſorders, the coheſion of the blood is diſſolved, and it aſſumes an alkaline nature, almoſt as if from putrefaction.

The blood contains in its ſubſtance a quantity of *ſea ſalt*, which is diſcernible to the taſte, and ſometimes viſible by the microſcope. That there is *earth* in the blood is demonſtrated from nutrition, and from a chemical analyſis; and this earth is chiefly found in the moſt fluid, and eſpecially in the oily parts of the blood. By ſome very late experiments, it appears, that a conſiderable quantity of ferruginous earth, eaſily reducible into metal by the addition of phlogiſton, is contained in the blood when calcined. Laſtly, another part in the blood is *air* in an unelaſtic ſtate, and that in a very conſiderable quantity, as is proved by the putrefaction and diſtillation, or by removing the ambient air by the pump; but we are not to ſuppoſe that the blood-globules are bubbles full of air, for they are ſpecifically heavier than the ſerum.

By the admixture of neutral ſalts the colour of the blood becomes deeper and brighter, without the blood's being either diſſolved or thickened. It is ſcarcely altered by a weak acid. By fermented liquors it is coagulated. Fixed alkaline ſalts have almoſt the ſame effects as the neutrals. The vola-

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tile alkalies rather turn it brown, and coagulate it. Alcohol and diſtilled oils, and likewiſe vinegar, coagulate it. It does not effervesce with any ſalt.

Chemiſtry has, in various ways, ſhewn us the nature of the blood. 1. When freſh drawn, before it has time to putrify, the blood, diſtilled with a ſlow heat, yields a *water* to the quantity of five parts in ſix of the whole maſs; which water has little or no taſte or ſmell, till towards the end of the operation, when it is proportionally more charged with a foetid oil. 2. The reſiduum, expoſed to a ſtronger fire, yields various alkaline liquors, of which the firſt, being acrid, foetid, and of a reddiſh colour, is uſually called the *ſpirit* of blood; it conſiſts of a volatile ſalt, with ſome little oil, diſſolved in water, to the amount of one twentieth part of the original maſs of blood. This ſame acrimonious ſubſtance is obſervable in the fat, and likewiſe in putrid fleſh and blood. 3. A little before, and together with the oil, a dry *volatile ſalt* ariſes, and adheres in branchy flakes to the neck and ſides of the glaſs. The quantity of this ſalt is very ſmall, being leſs than an eightieth part of the whole maſs. 4. The next liquor is *oil*; it is at firſt yellow, afterwards black, and at laſt reſembles pitch, being very acrid and inflammable: It makes about a fiftieth part of the whole maſs. 5. There remains in the bottom of the retort a ſpongy inflammable coal or cinder, which, being kindled, burns and leaves aſhes behind. From theſe aſhes, by lixiviation with water, is obtained a *mixed ſalt*, partly ſea-ſalt, and partly fixed alkali, together with a ſmall quantity of fixed earth. This fixed ſalt is ſcarce the five hundredth part of the maſs, and of this only one-fourth part is alkaline: But being calcined with an intenſe fire, the whole ſalt affords ſome portion of *an acid ſpirit*; which we ſuppoſe to be owing partly to the ſea-ſalt in the blood, ſome of which is demonſtrable even in the ſpirit of blood; and partly to the vegetable aliments, not yet digeſted

geſted into an animal nature. For which laſt reaſon an acid is procurable from the blood of graminivorous animals as well as from that of man. The earth, ſeparated from the lixivium by filtration, makes about an hundred and fiftieth part of the original maſs, and contains ſome particles which are attracted by the load ſtone.

From the preceding analyſis of the blood, it evidently contains a variety of particles, differing in bulk, weight, figure, and tenacity; ſome watery, others inflammable, and moſt of them greatly inclined to putrefaction, and of an alkaline nature. The blood, in a ſound healthy ſtate, not injured by putrefaction, or too violent a degree of heat, is neither alkaline nor acid, but mild or gelatinous, and a little ſaltiſh to the taſte; yet, in ſome diſeaſes it is very acrid, and comes near to a ſtate of putrefaction; as for inſtance, in the ſcurvy, where it corrodes its containing veſſels; and in dropſies, the waters of which are frequently alkaline. But an alkaleſcent calx is found in the blood of inſects, which effervesces with acids.

By a microſcope we perceive in the blood red globules; which, doubtleſs, make that part called *cruor* or *craſſamentum*. If it be queſtioned, whether theſe are not rather lenticular particles of the ſame kind with thoſe obſerved by Leuwenhoek in fiſh, and lately diſcovered in our own ſpecies, we confeſs it is a point difficult to determine: Hewſon, however, obſerves that the particles are flat like a guinea. (See his Treatiſe on the Blood.)

The colour of theſe globules is red; and the intenſeneſs of their colour, and the proportion they bear to the whole maſs, increaſes with the ſtrength of the animal. Their diameter is very ſmall, being between $\frac{1}{1000}$ and $\frac{1}{1000}$ of an inch. They are ſaid to change their figure into an oblong egg like ſhape, which Dr Haller could never obſerve with ſufficient certainty. They are alſo ſaid to diſſolve into other leſſer globules

globules of a yellow colour, which he had neither obſerved himſelf, nor can eaſily admit.

From the red part of the blood, fibres are generated in abundance; from the ſerum, in ſmaller quantities. They are procured by pouring the blood into a linen cloth, and waſhing it gradually with a great deal of water, or by beating it with a rod. In quantity, they equal the 28th part of the whole maſs. Theſe are formed of the gluten, and are not generated in a living animal; ſince they are neither to be perceived by the microſcope, which ſo eaſily renders viſible the red globules; nor yet does their long thread-like figure ſeem adapted for receiving motion.

From the preceding experiments compared together ariſes that knowledge which we at preſent have of the blood; namely, that the craſſamentum or cruor is compoſed of globules. The inflammable or combuſtible nature of theſe globules is proved from dried blood, which takes flame and burns; as alſo from the pyrophorus, which is generated from the human blood: And from globules alſo moſt probably ariſes the greater part of the pitchy oil that is obtained from blood by the violence of fire.

The ſerum of the blood diſtilled with a ſtrong fire gives over almoſt the ſame principles with the cruor, viz. ſalt, oil, and earth. It yields, however, much more water, but no iron at all. Similar principles, but with a leſs proportion of oil and ſalt, are obtained from the aqueous humours prepared from the blood, as the ſaliva and mucus.

The exact maſs or quantity of blood contained in the whole body cannot be certainly computed. The weight of the maſs of humours, however, is much greater than that of the ſolids; but many of them, as the gluten and fat of particular parts, do not flow in the circulation. But, if we may be allowed to form a judgment from thoſe profuſe haemorrhagies that have been ſuſtained without deſtroying the life

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of the patient, and from experiments made on living animals by drawing out all their blood, the mafs of circulating humours will be at leaft fifty pounds; of which, about 28 will be true red blood, running in the arteries and veins; of which the arteries contain only four parts, and the veins nine.

The blood does not always contain the fame proportion of the principles above mentioned: For an increafed celerity, whether by laborious and ftrong exercifes, a full age, fever, or otherwife, augments the craffamentum, the rednefs, the congealing force, and the cohefion of the particles; and the hardnefs and weight of the concreted ferum with the alkaline principles are increafed by the fame means. On the other hand, the younger and lefs active animal, and the more watery or vegetable the diet on which it is fed, the craffamentum of the blood is proportionally leffened, and its ferum and mucus increafed. Old age, again, leffens the craffamentum, and the gelatinous part likewife.

From thefe principles, and a due confideration of the folid fibres and veffels, the different temperaments are derived. For a *plethoric* or *fanguine* habit arifes from an abundance of the red globules; a *phlegmatic* temperature from a redundancy of the watery parts of the blood; a *choleric* difpofition of the humours feems to arife from a more acrid and alkalefcent property of the blood; as appears from thofe who live on flefh and on the human fpecies, being fo much fiercer and more paffionate than thofe who live on vegetable food. A great firmnefs in the folid parts, joined with an exquifite fenfibility, or nervous irritability, difpofes to a choleric habit; a lefs irritability, with a moderate denfity, to a fanguine habit; and a leffer degree, both of denfity and irritability, are to be referred to a phlegmatic temperament.

There is alfo a kind of dull heavy temperament, in which there is the greateft ftrength of body, joined with no great degree of irritability. In the melancholic, again, a weaknefs

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of the ſolids is joined with the higheſt degree of nervous irritation or ſenſibility. But we muſt not deſcribe the temperaments too ſyſtematically; for they are found to be not only four or eight, but almoſt infinitely varied.

The red part of the blood ſeems chiefly of uſe to generate heat, ſince its quantity is always in proportion to the heat of the blood. This being confined by the largeneſs of the globules, within the red or firſt order of veſſels, hinders them from collapſing; and, in receiving the common motion of the heart by the greater denſity of its parts, it has a greater impetus, and ſets in motion the leſſer orders of humours. Nor is it improbable that the heart is more ſtrongly irritated by the ponderous cruor of the blood. The globular figure of its parts, together with their denſity, makes it eaſily pervade the veſſels; and the quantity of iron it contains, as well as of oil, perhaps increaſes its power of generating heat. And hence it is, that the red part of the blood being too much diminiſhed by profuſe bleedings, there follows a ſtagnation or leſſened motion of the humours in the ſmaller veſſels; whence fatneſs and dropſy. By the ſame rule alſo a due proportion of cruor is neceſſary within the habit, to generate new blood. For, by large hemorrhagies, we ſee the blood loſes its red and denſe nature, and degenerates into a pale, ſerous, or watery ſtate.

The coagulable ſerum is more eſpecially deſigned for the nutrition of the parts, as ſhall be afterwards ſhewn. The thinner juices ſerve various purpoſes; as the diſſolution of the aliments, the moiſtening of the external ſurface of the body and ſurfaces of the external cavities, to preſerve the flexibility of the ſolids, and conduce to the motion of the nerves, the ſight, &c. The ſaline particles ſeem ſerviceable for diſſolving the aliment, and ſtimulating the veſſels. The properties of the aërial part are not yet well known. The heat occaſions

the fluidity, and is not eaſily raiſed to ſuch a degree as to coagulate the humours.

Health, therefore, cannot ſubſiſt without a denſe and red blood; and, if its quantity be too much diminiſhed, a ſtagnation of the juices takes place, whence the whole body becomes pale, cold, and weak. Nor can life or health ſubſiſt without a ſufficiency of thinner juices intermixed with the red blood; ſince the cruor, deprived of its watery part, congeals and obſtructs the ſmalleſt paſſages of the veſſels, and cauſes too great a heat.

It ſhould ſeem that there ought to be a difference between the arterial and venous blood, on account of the former's having lately ſuffered the action of the lungs: But, in experiments, I ſcarcely find any obſerveable difference, either in colour, denſity, or any other property. Sometimes, however, I have found a moſt evident difference; for the bright colour of the arterial blood ſeems to diſtinguiſh it from the duſky dark coloured blood in the veins. The dark colour of the blood in a chicken, while in the egg, ariſes only from the deep ſeat of the vein. But we have not ſufficient certainty of a difference in the blood of different arteries. However, the arterial blood is apparently of a more bright or ſplendid red, and having a greater degree of fluidity and proportion of watery parts, may ſo far differ from the venous darker coloured blood. But, to clear up this circumſtance, farther experiments are requiſite.

From one and the ſame maſs of blood, driven into the aorta, are generated all the fluids of the human body; which, from their affinity to one another, are reducible to certain claſſes. The manner in which they are ſeparated ought to be accounted for by the fabric or mechaniſm of the glands themſelves. But we muſt firſt conſider what the blood ſuffers from its containing veſſels.

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" The theory of the temperaments of the human body (ſays Dr Wriſberg), in the ſenſe commonly received by phyſicians, and taught in the ſchools, the received diviſion of them into four ſpecies, and their repeated production from the different nature and mixture of the blood, ſavours too much of the ancient and particularly of the Galencial doctrine. I think there can be no doubt that there are temperaments; and that the manner and rule which nature follows in man, and likewiſe in perfect animals, may be obſerved in the performance of the corporeal and mental functions, in either preſerving or endangering the health and life, in the exerciſe of moſt of the duties and affairs of life, and in the actions of the internal and external parts, which are more or leſs connected with the health of the animal. If, therefore, we would wiſh to give any ſpecific name to this different relation and determination of the parts of our body, when once communicated with the ſyſtem in general, as we would do to any plant, or other particular natural body; or if we wiſh to keep the ancient denominations ſanguineous, choleric, phlegmatic, and melancholic, in preference to all others, we muſt be aware, that neither the various habits nor temperaments of mankind can originate ſolely from the different natures of the blood, nor can they all be comprehended under theſe four modifications.

" The cauſes of diverſity of temperament ſeems to be, 1. The various quantity, firmneſs, and ſentient faculty of the nervous ſyſtem, from the brain communicated to each nerve. I have always obſerved a choleric, and cholerico ſanguineous diſpoſition, in all perſons having a large brain and thick ſtrong nerves, along with a great ſenſibility as well of the whole body, as of the organs of ſenſe. Hence ariſes a ready apprehenſion of objects, and an increaſe of underſtanding and knowledge, and, owing to the compariſon of many ideas, an acute and entire judgment, which choleric perſons poſſeſs in

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ſo eminent a degree: But, along with this condition of the nerves, theſe people are exceſſively liable to grief and anger, when the body or mind is but ſlightly affected; and on this account medicines ſhould be cautiouſly given, and leſs doſes preſcribed to them. With a ſmall brain and ſlender nerves, I have obſerved the ſenſes more dull, and a phlegmatic or phlegmatico-melancholic torpor conjoined. Theſe people therefore require from external objects ſtronger impreſſions upon the organs of ſenſe, and theſe impreſſions longer applied, if they are meant to leave laſting effects: Hence their judgment is frequently weak on account of the defect of ideas; and they ſeldom acquire any extenſive knowledge. But nature has compenſated theſe diſadvantages, by making them more able to undergo hardſhips, from change of climate, life, or labour; they demand more powerful medicines, and larger doſes. What a great difference in man and the cetaceous animals! 2. The various degrees of irritability in the muſcular parts. For, wherever you find a very delicate irritability, affected by almoſt every ſtimulus, and retaining laſting impreſſions, and at the ſame time acting with a certain celerity; in that caſe you cannot doubt of a choleric diſpoſition. Hence that remarkable ſtrength in the muſcles of ſome perſons, which act with ſo incredible quickneſs, diſpatch, and conſtancy. On the contrary, if you examine a phlegmatic perſon, you obſerve the contractile power of the muſcles languid, difficultly yielding to ſtimuli, unleſs powerful; ſince the muſcles of phlegmatico-melancholic men are long of being determined to motion, although ſtrongly excited, and finiſh it with an appearance of languor. 3. Even a certain ſoftneſs is obſervable in all fibres and membranes, if you touch the body of a phlegmatic perſon; or a ſeeming hardneſs and dryneſs in melancholic habits: Along with which particularities the phlegmatics join leſs elaſticity, whilſt, in the melancholic, there is a greater tone and contractile power.

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4. There is in the air, undoubtedly, a certain electrical principle, which being by respiration communicated in different ways with the body, imparts a natural tone to the fibres, occasions a quicker motion in the vessels, and increases and diminishes by turns the alacrity of the mind. But, as this principle of atmospheric air does not prevail in equal quantity every hour of the day, all times of the year, and in every climate; so sometimes we feel an universal lassitude, which suddenly ceases, the strength of the body and mind being restored with a serene and elastic air; so, in like manner, all men do not equally absorb this electric matter, which thus forms a remarkable diversity of temperament. 5. We ought, too, to combine with these the various nature of the blood from the proportion of its elements: And, in fact, as greater stimuli in the blood excite the heart to brisker contractions; so a more acrid and copious bile may effectually promote the peristaltic motion, and the abundance of mucus occasion a tendency to lentor and frequent catarrhs.

"There are then sufficient causes, which, from our birth, may bring on, in the first growth of the parts of the body, an irrevocable determination to this or that habit or temperament. I therefore can scarcely admit a complete transmutation of temperament, which, during the exercise of these natural laws, could render a purely choleric person phlegmatic: But, that some change may take place in temperaments, that violent attacks may be mitigated, that lentor, torpor, and listlessness, may be increased, I readily agree; and, from the remedies by which such a change may be produced, I form a second class of the causes of temperaments. The chief are, 1. A different kind of meat and drink. An animal diet adds a great stimulus to our strength, invigorates our senses, and sometimes induces ferocity; as is evident from the Anthropophagi, carnivorous animals, wild beasts and their whelps, and hunters, particularly if the abuse of aromatics,

matics, wines, and medicines, has ſupervened. Vegetables, on the contrary, increaſe the lentor of the fibres, weaken the ſtrength, diminiſh ſenſibility and irritability; in a word, induce a phlegmatic diſpoſition; in which potatoes have a wonderful effect. It would be of great conſequence to pay regard to this in the bringing up of children, viz. to invigorate the inertia of the mental and corporeal faculties by the uſe of animal food, but to temper the vehement paſſions peculiar to choleric perſons, by uſing a vegetable diet. 2. The particular mode of education and examples. It need ſcarce be inſiſted on that theſe poſſeſs great influence, particularly in infancy. Hence it happens that whole nations are of one temperament. 3 Climate, weather, native country. Rarely in an unſettled climate or country, in hot climates, or in moiſt countries, will you find in choleric perſons that alacrity of temper, agility of body, and quickneſs of underſtanding, which is ſo common in a ſerene and temperate climate, and high hilly countries. 4. The increaſe of knowledge. I have often admired that change which a ſtrenuous induſtry produces in ſome of the moſt dull men; ſo that, with the increaſe of knowledge, they became of a more cheerful temperament. 5. Abundance and want of neceſſaries, both in life, and for the purpoſe of forwarding improvement. For this reaſon, it may happen that, according to the diverſity of the form of government, whether under mild or more ſevere and tyrannical laws, the temperament of the ſubject may be either lively or languid. 6. The ſort of life itſelf, intercourſe with men, and public employment, may have a great ſhare in changing temperaments; ſince rarely, after the 36th year of a man's life, do you find the blood ſtill pure; and a choleric perſon ſcarcely preſerves his former alacrity after his 50th. It is difficult to ſay into how many ſpecites emperaments ſhould be divided, and what kind of character ſhould be aſſigned to each, according to nature, and not conjecture. I doubt I may

may not be more ſucceſsful than the celebrated Kaempfius and Gerreſhemius, as I exhibit the outlines only. The ſanguineous and phlegmatic temperaments ſeem, with various intermedia, to comprehend all modifications. 1. The ſanguineous, which is inconſtant, and not well ſpecified, is diſtinguiſhed by a vivid colour of the face; the veſſels are full; and hence, for the moſt part, they take ill with external heat; they are prediſpoſed greatly to inflammatory diſeaſes; they have a great ſhare of ſenſibility and irritability, which all therefore indicate a deſire of pleaſure in this temperament, and the greateſt inquietude, both of body and mind, prevails: They are talkative; abide not long with any occupation; they are eaſily ſeduced, and contract an intimacy with every body; but they ſoon forget their friends, ſhewing a certain diffidence to all of them; they ſeldom meddle with affairs of any conſequence; and rarely acquire proficiency in the ſciences, unleſs in an advanced age. 2. The ſanguineous choleric enjoys a better mixture of cauſes; it has the ſupports of health and cheerfulneſs along with the former, but has perſeverance in common with the choleric. 3. The choleric: Here you will always obſerve the body lean, though not emaciated and dry, as in the caſe with melancholic; the ſkin is of a whitiſh yellow, with red hairs; the balls of the eyes are of a moderate magnitude, the pupil being frequently dim; a penetrating lively countenance, ſometimes joined with a degree of ferocity; a quick pulſe; action of the muſcles in walking, ſpeaking, and other reſpects, very rapid; copious and acrid bile; hence an effectual periſtaltic motion, more frequent ſtools, a ready inclination to undertake any thing of conſequence, formed as if to command, and particularly fond of animal food. 5. The hypochondriac: An unhappy temperament, troubleſome to itſelf and others. Men of this ſort, for the moſt part, are ſubject to diſeaſes in the liver, have a yellowiſh appearance, always diſcontented, wonderfully tortured

tured with envy and diffidence, and are called by ſome *choleriço-melancholic*. 6. The melancholic have a dejected aſpect: The eyes, for the moſt part, ſmall, retracted, and winking; the hair black, and ſkin rigid; remarkable for its dryneſs and leanneſs; a ſmall and ſlow pulſe, ſparing and black bile, a ſlow periſtaltic motion. They indeed have quick perceptions, and ponder long; they ſubmit to toilſome labour with the greateſt patience, but finiſh it with incredible ſlowneſs; for the moſt part they pay no regard to time. They eaſily bear the diſadvantages of life; but, when once their anger is excited, they love revenge. 7. The boeotic or ruſtic joins a great ſhare of the ſanguineous temperament with the melancholic and phlegmatic. The body is luſty, full of juices, a ſmall irritability in its ſtrong muſcles, and ſome ſtupor in its ſmall nerves. Perſons of this ſort are capable of no education; and whatever they undertake ſavours of a low turn of mind. 8. The gentle and mild temperament. This is compoſed of the ſanguineous, choleric, and phlegmatic. They are a good race of men, wiſhing well to all: In them we always perceive a calmneſs and ſweetneſs of manners. They ſtrongly hate a prating, noiſy loquacity. If devoted to ſtudy, they calmly undertake the taſk, anxiouſly ponder what they learn, and are capable of great proficiency. 9. The ſlow phlegmatic is diſtinguiſhed by a ſoft and moſtly whitiſh ſkin, a very lax body, very prominent eyes, drowſy aſpect, a ſlow and weak pulſe: For the moſt part they ſpeak ſlow, are patient of the weather's inclemency, and other people's affronts; born to obey; and on account of their ſlighter irritability, difficultly enraged, and eaſily pacified again.

§ 8.

§ 7. *Of the Circulation or Motion of the Blood through the Arteries and Veins.*

THE arteries and veins contain either blood or lymph. The red blood fills thoſe arteries and veins which we call *red*, or of the firſt order, and which have their origin in the heart. Sometimes they are very looſely and imperfectly diſtended by the blood, and at other times they are rendered very full and turgid. After death, the veins are found fuller of blood than the arteries; and ſometimes when the perſon has been dead a conſiderable time, the ſmall veins have been found diſtended with air. But the arteries of a dead body commonly contain only a ſmall quantity of blood.

This diſtending blood is rapidly moved through all the veſſels of a living body, as is demonſtrated to us from wounds; and the patient ſooner or later expires from the loſs of ſo much blood as was neceſſary for the maintenance of life; this loſs of blood happens almoſt inſtantly from the larger arteries; and ſometimes very ſuddenly from the ſmaller ones: But from the veins, unleſs they are ſome of the largeſt, it is generally ſlow; yet are there not wanting inſtances of fatal hemorrhagies from wounds of the veins, in the inner corners of the eyes, and thoſe under the tongue. Experiments made upon living animals ſufficiently evince the impulſe and rapidity with which the blood is moved, particularly through the arteries. The height to which blood aſcended from the carotids, when cut, according to Hale's calculation, Dr Wriſberg ſaw confirmed in robuſt men who were beheaded: It is generally about ſeven feet, with this difference, however, that in two examples the blood ſprung higher from the vertebrals than from the carotids. In the larger trunks it runs ſwifteſt, but in the leaſt of them, ſomewhat ſlower. In the larger veins, the blood's celerity

is leſs than in the arterial trunks, in the ſame proportion as the ſections of the arteries are leſs than thoſe of the veins, *i. e.* twice or almoſt thrice as ſlow. Another argument of the circulation is the compreſſure and relaxation of a vein, whereby the motion of the blood is promoted from one valve to another. The motion of the blood through the veins is uniform or equable; but in the arteries, it is alternately greater when the veſſel is more dilated, and leſs when it is contracted. This is proved by ocular inſpection in living animals.

That the motion of the blood is a continued courſe through the ſanguineous arteries into the veins, is diſcovered from experience. For, firſt, it is certain, that all the arteries and veins communicate or open the one into the other: becauſe, often from one, and that a ſmall artery, all the blood of the whole body may be evacuated. We have numerous examples of fatal hemorrhagies from an inner artery of the noſe, from the gums, from a finger, from a tooth, from a cutaneous pore enlarged, from the punctum lacrymale, from the wound of cupping, and even from the bite of a leech. There are, therefore, of courſe, open ways, by which the blood ſpeedily flows from the venous into the arterial ſyſtem.

That the blood, again, in the arteries, flows from the heart towards the extreme parts of the body, is proved by the microſcope, and by a ligature on the artery of a living animal, and likewiſe by the fabric, mechaniſm, and proportion of the ſemilunar valves between the arteries and their correſponding ventricles. Whatever artery is ſtopped by a ligature, the ſwelling enſues in that part between the heart and the ligature, whilſt the other part beyond the ligature, which is more remote from the heart, is emptied. Neither has it there any pulſation, nor, if it be there wounded, will it yield any blood. The ſame effects which we ſee follow from a ligature, are likewiſe often produced by diſ-

eaſe;

eaſe; as when ſome tumour, by compreſſure or an aneuriſm, intercepts the blood's motion from the heart. Experiments of this kind have been made on moſt of the arteries; anaſtomoſes, however, or the blood flowing through a neighbouring branch, or the retroceſſion of the blood in a dying animal, form exceptions to this rule.

But the courſe or motion of the venous blood has been always more doubted; almoſt all the antients have been perſuaded, that the blood in the veins flowed through them, either from the heart or from the liver, to all parts of the body. Very few of them have known that this was an error. Several of them have, indeed, acknowledged it to be falſe in the pulmonary vein. But that the blood did not move from the heart in the vena cava was known to ſtill fewer anatomiſts of the antients: Only to Andreas Caeſalpinus by chance, and (from an extraordinary accident) to Veſalius.

Dr William Harvey was the firſt who experimentally aſſerted the motion of the blood returning in the veins to the heart, in ſuch a manner as to render the whole intelligible, and leave no room for doubt. The valves of the veins lead us to this truth: For the common uſe or office of theſe valves is, to determine the preſſure that is made from any quarter upon the veins, towards the heart, by allowing no opportunity to the venous blood that has once entered the trunk to flow back to the branches. For, ſince the valves open upwards towards the heart, the blood enters and expands them; and thoſe parts of the valves which project into the cavity of the vein, approach towards the axis, until the oppoſite ſides, by meeting together, ſhut up the tube. This we know from inflations, ligatures, and injections of the veins; for you never can force a liquor eaſily into the veins by propelling it againſt their valves. They do not, indeed, every

where

where ſhut up the whole cavity of the veins; but where they do not ſhut cloſe, they always intercept the greateſt part of the tube.

Another office of the valves in the veins ſeems to be for ſuſtaining the weight of the blood, that its upper columns may not gravitate upon the lower; nor the blood, flowing through the trunks, make too great a reſiſtance againſt that which follows it through the branches: For if, from the ſlower motion of the blood, its weight or preſſure ſhall, in any part, much exceed the impulſe that drives it on, ſo as to cauſe ſome part of the column to deſcend by its weight, it is, in that caſe, immediately catched, and ſuſtained in its relapſe by the next adjacent valve, which hinders it from urging againſt the next ſucceeding column, and affords time and opportunity for ſome contiguous muſcle, by its preſſure or concuſſion, to propel the column. This is the reaſon why valves are placed in the veins of the limbs and necks, in which parts they are both more numerous and more robuſt than elſewhere. This is alſo the cauſe of varices, when the blood, entering the hollow valves, urges their ſolid convexity downwards, and makes the vein dilate in that part. Likewiſe, in muſcular action, the valves are the cauſe of the whole effect of the preſſure which the veins ſuſtain, forwarding the blood in its due courſe towards the heart.

Moreover, the valves placed in the right ſide of the heart are ſo conſtructed, that they freely permit blood, air, or wax, to paſs from the venous trunks of the cava into the heart, but deny any reflux from the heart into the veins.

Again, ligatures, in a living perſon, make this circumſtance more evident. When the veins of the limbs are tied, either by deſign or accident, about the hams, arms, ancles, or wriſts, the limb below the ligature ſwells, the veins fill and diſtend themſelves, and, when opened, make a free diſcharge of blood: But at the ſame time nothing of this kind happens

above

above the ligature, nor any of the veins to be ſeen there. The ſame phenomenon happens when the veins are compreſſed by ſwelled or ſcirrhous glands in the viſcera; and from polypuſes the veins are often greatly ſwelled or enlarged into tumours. Theſe ligatures will ſerve to keep the blood in any limb round which they are tied, that it may not return to the heart, and be loſt through a wound in another part.

The experiments which have been made in living animals, to prove this courſe of the blood, are ſtill more accurate. From them, even from our own, it appears, that by tying any vein, in a living animal, near the cava, or belonging to the pulmonary veins, that part always ſwells which is moſt remote from the heart, all below the ligature appearing diſtended with the retained blood, while above and next the heart they are pale and flaccid. Laſtly, if the arteries are tied at the ſame time with the veins, theſe laſt remain flaccid and empty; but, upon removing the ligature from the arteries, the veins are immediately filled.

In like manner, the infuſion of poiſons or medicinal liquors ſhew, that, into whatever vein you inject chemical acid ſpirits, the force of the poiſon is driven along with the blood to the heart itſelf. That the brain is affected with the narcotic virtue of opium, and the inteſtines and ſtomach with the virtue of purgatives and emetics injected into the veins, is a demonſtration that the blood, with which theſe ſubſtances were mixed, had paſſed through the ramifications of the veins to the heart, and from thence through the whole body.

We have another proof in the *transfuſions* of blood; in which all the blood from the arteries of one animal is urged into the veins of another exhauſted of blood; whereby the heart, arteries, and empty veins of the later, becomes ſo turgid, and well repleniſhed, that they produce a remarkable degree of vivacity in the animal, or even cauſe it to labour under a plethora.

That

That the blood paſſes from the leaſt arteries into the leaſt veins, we are clearly taught by *anatomical injection*; where, by one arterial trunk, we eaſily fill all the arteries and veins, almoſt throughout the whole body, provided the liquor be watery, or very fluid, ſo as to paſs eaſily into the veſſels of the head, meſentery, heart, and lungs.

Laſtly, *the microſcope* has put the matter beyond all doubt; in the pellucid tails, feet, and meſenteries, of animals, we ſee that the blood, brought to the extreme parts by the arteries, is poured either into ſmall veins continuous with the reflected artery, or elſe goes through branches of the arterial trunk into the parallel communicating vein, by which it goes on to the parts neareſt the heart. This is the way in which the blood paſſes, as well into the leaſt veins which are capable of receiving only one globule, as into thoſe that are ſomewhat larger, and are able to admit two or more globules to advance forward together. That there is no ſpongy or parenchymous interpoſition between the arteries and veins, in the general courſe of the circulation, is proved both from microſcopic obſervations and injections. For, if there were any ſuch parenchyma or ſpongy maſs between the arteries and veins, the hardening injections would ſhew it, by appearing extravaſated in an unſhapen maſs.

The circulation of the blood is therefore now received by every one as a medical truth; namely, that all the blood of the human body is carried through the aorta, from the left cavity of the heart, to the extreme parts or converging ends of the arterial branches; from whence the whole maſs is again tranſmitted into the leaſt veins, which convey it to the larger, and from them into the cava and heart itſelf; in which courſe it perpetually goes and returns during life.

Yet there are not wanting ſome inſtances where, by paſſions of the mind, by copious blood-letting or convulſions, the blood has been forced to recede back from the

ſmaller

ſmaller into the larger arteries; and, on the other ſide, where an obſtruction has been formed above the valves, the blood has been known to ſlide back from the venous trunks into their ſmaller branches. But then theſe accidents are very momentaneous or ſudden, and the blood ſoon returns into its natural courſe. Theſe things happen moſt frequently in the abdomen and vena portarum.

The courſe of the humours in the *lymphatic veins* which have valves, appears both from the nature of thoſe veins, and from ligatures: For every lymphatic vein, when tied, ſwells between its ſmaller extremities and the thoracic duct; but grows flaccid between the duct and the ligature. All the valves in theſe, like thoſe of the blood veins, give a free paſſage for flatus and mercury to flow to the thoracic duct: But they make a reſiſtance, and often an obſtinate one, to any return the other way; although ſometimes they have been known to yield.

The *vapours* that moiſten the whole cellular ſubſtance, the ſteams of the abdomen and other cavities, are all abſorbed by the leaſt pellucid veins, and ſo conveyed to the blood veins, that their contained juices may paſs on to the heart: And from thence it is that oedema enſues, when a vein is compreſſed by a ligature; becauſe, by intercepting the courſe of the abſorbing veins by the ligature, the vapours being unabſorbed, ſtagnate. In the other ſmaller veſſels we can make no experiments; but they appear conformable to what we have ſaid of the larger veſſels, both from reaſon and analogy. This doctrine is likewiſe ſupported by the experiments of water, or other liquors, abſorbed out of the cavity of the inteſtines, thorax, aud pulmonary veſicles.

All the juices, therefore, in the human body, are driven out of the heart into the aorta; from whence they are all returned again to the heart by the veins; thoſe humours only excepted which are exhaled or diſcharged out of the body.

body. To complete this circle, it only remains for us to find out a courſe for the blood from the right to the left cavities of the heart; but this firſt ſuppoſes us to be acquainted with the hiſtory of the lungs and the pulmonary veſſels.

§ 8. *Lungs.*

Situation in general, and figure. The lungs are two large ſpongy bodies, of a reddiſh colour in children, greyiſh in adult ſubjects, and bluiſh in old age: They fill the whole cavity of the thorax, one being ſeated in the right ſide, the other in the left, and are parted by the mediaſtinum and heart. They are of a figure anſwering to that of the cavity which contains them; that is, convex next the ribs, concave next the diaphragm, and irregularly flatted and depreſſed next the mediaſtinum and heart.

When the lungs are viewed out of the thorax, they repreſent, in ſome meaſure, an ox's foot, with the forepart turned to the back, the back part to the ſternum, and the lower part to the diaphragm.

Diviſion and figure in particular. They are diſtinguiſhed into the right and left lung; and each of theſe into two or three portions called *lobi*, of which the right lung has commonly three, or two and a half, and the left lung two. The right lung is generally larger than the left, anſwerable to that cavity of the breaſt, and to the obliquity of the mediaſtinum.

At the lower edge of the left lung, there is an indented notch or ſinus oppoſite to the apex of the heart, which is therefore never covered by that lung, even in the ſtrongeſt inſpirations; and conſequently the apex of the heart and pericardium may always ſtrike againſt the ribs; the lungs not ſurrounding the heart in the manner commonly taught. This ſinus is expreſſed in Euſtachius's Tables.

Structure.

Structure. The ſubſtance of the lungs is almoſt all ſpongy, being made up of an infinite number of membranous cells, and of different ſorts of veſſels ſpread among theſe cells, in innumerable ramifications.

Coats. This whole maſs is covered by a membrane continued from each pleura, which is commonly ſaid to be double; but what is looked on as the inner membrane is only an expanſion and continuation of a cellular ſubſtance, which ſhall be ſpoken to after I have deſcribed the veſſels of this viſcus.

Bronchia. The veſſels which compoſe part of the ſubſtance of the lungs are of three or four kinds; the air-veſſels, blood-veſſels, and lymphatics, to which we may add the nerves. The air veſſels make the chief part, and are termed *bronchia.*

Theſe bronchia are conical tubes, compoſed of an infinite number of cartilaginous fragments, like ſo many irregular arches or circles, connected together by a ligamentary elaſtic membrane, and diſpoſed in ſuch a manner as that the lower eaſily inſinuate themſelves within thoſe above them.

They are lined on the inſide by a very fine membrane, which continually diſcharges a mucilaginous fluid; in the ſubſtance of the membrane are a great number of ſmall blood-veſſels, and on its convex ſide many longitudinal lines, which appear to be partly fleſhy and partly made up of an elaſtic ſubſtance of another kind.

The bronchia are divided, in all directions, into an infinite number of ramifications, which diminiſh gradually in ſize; and, as they become capillary, change their cartilaginous ſtructure into that of a membrane. Beſides theſe very ſmall extremities of this numerous ſeries of ramifications, we find that all the ſubordinate trunks, from the greateſt to the ſmalleſt, ſend out from all ſides a vaſt number of ſhort capillary tubes of the ſame kind.

Veſiculae bronchiales. Each of theſe numerous bronchial tubes is widened at the extremity, and thereby formed into a ſmall membranous cell, commonly called *a veſicle*. Theſe cells or folliculi are cloſely connected together in bundles; each ſmall branch producing a bundle proportional to its extent and the number of its ramifications.

Lobuli. Theſe ſmall veſicular or cellulous bundles are termed *lobules*; and, as the great branches are divided into ſmall rami, ſo the great lobules are divided into ſeveral ſmall ones. The cells or veſicles of each lobule have a free communication with each other, but the ſeveral lobules do not communicate ſo readily.

Interlobular ſubſtance. The lobules appear diſtinctly to be parted by another cellulous ſubſtance, which ſurrounds each of them in proportion to their extent, and fills up the interſtices between them. This ſubſtance forms likewiſe a kind of irregular membranous cells, which are thinner, looſer, and broader than the bronchial veſicles.

This ſubſtance is diſperſed through every part of the lungs, forms cellulous or ſpongy vaginae, which ſurround the ramifications of the bronchia and blood-veſſels, and is afterwards ſpread over the outer ſurface of each lung, where it forms a kind of fine cellular coat, joined to the general covering of that viſcus.

When we blow in this interlobular ſubſtance, the air compreſſes and flattens the lobuli; and, when we blow into the bronchial veſicles, they immediately ſwell; and, if we continue to blow with force, the air paſſes inſenſibly into the interlobular ſubſtance. We owe this obſervation to M. Helvetius.

Vaſcular texture. All the bronchial cells are ſurrounded by a very fine reticular texture of the ſmall extremities of arteries and veins, which communicate every way with each other. The greateſt part of this admirable ſtructure is the diſcovery of the illuſtrious Malpighi.

Blood-

Blood-veſſels. The blood-veſſels of the lungs are of two kinds; one common, called *the pulmonary artery and veins*: the other proper, called *the bronchial arteries and veins.*

The pulmonary artery goes out from the right ventricle of the heart; and its trunk, having run directly upward as high as the curvature of the aorta, is divided into two lateral branches; one going to the right, called *the right pulmonary artery*; the other to the left, termed *the left pulmonary artery.* The right artery paſſes under the curvature of the aorta, and is conſequently longer than the left. They both run to the lungs, and are diſperſed through their whole ſubſtance by ramifications nearly like thoſe of the bronchia and lying in the ſame directions.

The pulmonary veins having been diſtributed through the lungs in the ſame manner, go out on each ſide, by two great branches, which open laterally into the reſervoir or muſcular bag of the right auricle.

The ramifications of theſe two kinds of veſſels in the lungs are ſurrounded every where by the cellular ſubſtance already mentioned, which likewiſe gives them a kind of vagina; and the rete mirabile of Malpighi, deſcribed above, is formed by the capillary extremities of theſe veſſels. It muſt be obſerved, that the ramifications of the arteries are more numerous and larger than thoſe of the veins, which, in all other parts of the body, exceed the arteries, both in number and ſize.

Bronchial arteries and veins. Beſides theſe capital blood-veſſels, there are others called the *bronchial arteries and veins*, which are very ſmall, but they follow the bronchia through all their ramifications. They communicate with the pulmonary arteries and veins in many places; and likewiſe with the arteries and veins of the oeſophagus, and with the branches of the coronary artery and vein.

The

The varieties in the origins of the bronchial arteries and veins, especially of the arteries, their communications or anastomoses with each other and with the neighbouring vessels, and, above all, the immediate anastomosis of the bronchial artery with the common pulmonary vein, are of so great consequence in the practice of physic, that it will be proper to repeat here what we have said about them elsewhere, that the attention of the readers may not be diverted by being obliged to turn to another part of this work.

The bronchial arteries come sometimes from the anterior part of the aorta descendens superior, sometimes from the first intercostal artery, and sometimes from one of the oesophagaeae. They go out sometimes separately, toward each lung; sometimes by a small common trunk, which afterwards divides to the right and left, near the bifurcation of the aspera arteria, hereafter to be described, and follow the ramifications of the bronchia.

The left bronchial artery frequently comes from the aorta; and the right, from the superior intercostal on the same side, because of the situation of the aorta. There is likewise another which arises from the aorta posteriorly near the superior intercostal, and above the anterior bronchialis.

The bronchial artery gives off a small branch to the auricle of the heart on the same side, which communicates immediately with the coronary artery.

Sometimes one bronchial artery gives origin to several superior intercostals; and sometimes several bronchial arteries send off separately the same number of intercostals.

The bronchial veins, as well as arteries, were known to Galen. The vein on the left side goes into the left superior intercostal vein, while the trunk on the right side passes into the vena azygos; and sometimes both veins are branches of the gutturalis.

Nerves. The lungs have a great many nerves distributed through

through them by filaments which accompany the ramifications of the bronchia and blood-veſſels, and are ſpread on the cells, coats, and all the membranous parts of the lungs. The eighth pair, and great ſympathetic nerves, form, behind each lung, a particular intertexture, called *plexus pulmonaris*; from whence nervous filaments go out, which communicate with the plexus cardiacus and ſtomachicus.

Lymphatic veſſels. On the ſurface of the human lungs, between the external and cellular coat, we obſerve lymphatic veſſels: But we ought to take care not to miſtake for ſuch veſſels a tranſparent reticular ſubſtance obſervable on the ſurface of the lungs, after blowing ſtrongly into the lobuli; this appearance being entirely owing to the air which paſſes through the bronchial veſicles into the interlobular cells, and which, by ſeparating a certain number of lobuli, finds room to lodge between them.

Ligaments. Under the root of each lung, that is, under that part formed by the ſubordinate trunk of the pulmonary artery, by the trunks of the pulmonary veins, and by the trunk of the bronchia, there is a broad membranous ligament which ties the poſterior edge of each lung to the lateral parts of the vertebrae of the back, from that root all the way to the diaphragm.

Trachea arteria. The bronchia already deſcribed are branches or ramifications of a large canal, partly cartilaginous, and partly membranous, called *trachea* or *aſpera arteria*. It is ſituated anteriorly, in the lower part of the neck, from whence it runs down into the thorax between the two pleurae, through the upper ſpace left between the duplicature of the mediaſtinum behind the thymus.

Having reached as low as the curvature of the aorta, it divides into two lateral parts, one toward the right, the other toward the left, which enter the lungs, and are diſtributed through them in the manner already deſcribed. Theſe two branches

branches are called *bronchia*; and that on the right ſide is ſhorter than that of the left, whereas the right pulmonary artery is the longeſt.

The trachea conſiſts of ſegments of circles or cartilaginous hoops, diſpoſed in ſuch a manner as to form a canal open on the back part, the cartilages not going quite round; but this opening is filled by a ſoft glandular membrane, which completes the circumference of the canal; but this cannot be to give way to the oeſophagus, for, inſtead of deſcending immediately upon the middle of that canal, the trachea inclines a little to the right ſide, and the ſame ſtructure is found in the back part of the great bronchial veſſels, which are at ſome diſtance from the oeſophagus.

Each circle is about the twelfth part of an inch in breadth, and about a quarter of that ſpace in thickneſs. Their extremities are round; and they are ſituated horizontally above each other, ſmall interſtices being left between them, and the lower edge of the ſuperior ſegment being turned towards the upper edge of thoſe next below them.

They are all connected by a very ſtrong elaſtic membranous ligament fixed to their edges. I have obſerved the firſt three ſegments united into one ſubſtance, bent alternately in two different places, according to its breadth. Sometimes two are continuous in the ſame manner.

The trachea is covered externally with a quantity of cellular ſubſtance, which unites it to the neighbouring parts, and it is lined on the inſide by a particular membrane, which appears to be partly fleſhy or muſcular, and partly ligamentary, perforated by an infinite number of ſmall holes, more or leſs imperceptible, through which a mucilaginous fluid continually paſſes, to defend the inner ſurface of the trachea againſt the acrimony of the air which we breathe.

This fluid comes from ſmall glandular bodies diſperſed through the ſubſtance of the membrane, but eſpecially from glands

glands ſomething larger than the former, which lie on the outer or poſterior ſurface of that ſtrong membrane by which the circumference of the canal is completed. The ſame ſtructure is obſervable in the ramifications of the trachea from the greateſt to the ſmalleſt.

All the veſſels of which the lungs are chiefly compoſed, that is, the air veſſels, or bronchia, and the blood veſſels, or the pulmonary and bronchial arteries and veins, accompany each other through this whole viſcus.

They are commonly diſpoſed in ſuch a manner, even to the laſt ramifications, as that a ſubordinate trunk or branch of the bronchia lies between the like trunks or branches of the pulmonary artery and vein; the bronchial veſſels being immediately joined to the bronchia. In ſome places theſe three kind of veſſels touch each other in ſuch a manner as to leave a triangular ſpace in the middle.

The bronchia are divided into a very great number of ramifications; and the laſt rami are the pedicles or footſtalks of the ſmall lobuli. All the lobuli are angular, oblong, broad, thin, &c. The footſtalks ſend out other ſmaller membranous pedicles, which are very ſhort, and terminate in the bronchial veſicles or cells, of which they are continuations. The ſubordinate trunks and rami detach a great number of theſe pedicles from their convex ſurface.

When we blow into the lungs, the bronchial cells, neareſt their outer ſurface, appear like ſmall portions of round veſicles; and from this appearance all the bronchial cells have got the name of *veſicles*, though they are all angular, except thoſe which I have now mentioned.

When we examine a lung without blowing it up, we find that the cartilaginous ſegments of the bronchia lie ſo near as to be engaged in each other; and in drawing out any portion of the bronchia by the two ends, theſe ſegments are parted, and the whole canal is increaſed in length; but it contracts

contracts again, by means of its elaſtic membrane, as ſoon as that force is taken off.

When we open lengthwiſe any portion of the pulmonary artery and vein in the ſame lung, we meet with a great number of tranſverſe rugae, which are deſtroyed when theſe veſſels are elongated. This is an obſervation made by M. Helvetius.

In conſequence of this ſtructure, all the ramifications, both of the bronchia and pulmonary arteries and veins, have conſtantly the ſame direction, whether the lung be inflated or collapſed; and they contract in length, without being either contorted or folded. Theſe veſſels are elongated in exſpiration, and ſhortened in inſpiration.

Theſe three veſſels lie in a ſort of cellular vagina, which accompany all their ramifications; and is a continuation of their interlobular cells, or cellular ſubſtance, in the interſtices of the lobuli. The pelliculi which compoſe it are, however, there diſpoſed in a more regular manner, and more longitudinally, than in other places, and thereby appear to form a true vagina.

When we blow through a pipe introduced ſo far as to touch immediately a trunk of the blood veſſels or bronchia, the air runs at firſt through all the cells that lie neareſt that trunk or its branches; but if we continue to blow, it inſinuates itſelf through the whole interlobular ſubſtance.

Bronchial glands. At the angle of the firſt ramification of the trachea arteria, we find on both the fore and back ſides certain ſoft, roundiſh, glandular bodies, of a bluiſh or blackiſh colour, but reddiſh in a child; in ſize they vary from that of a field bean to that of a millet ſeed. Through theſe the lymphatic veſſels of the lungs paſs in their way to the thoracic duct.

The trachea has ſeveral coats, as has been already obſerved. The outermoſt or common covering ſurrounds that part of

of the trachea which lies in the thorax: but out of the thorax, this firſt coat is derived from the aponeurotic expanſions of the muſcles of the neck; and it is between this and the following covering, that the glands already mentioned are ſituated.

The ſecond is a proper coat, being a continuation of the cellular covering of the lungs; the pelliculae of which, neareſt the cartilaginous ſegments, ſerve them for an external perichondrium. The third membrane lies on the inſide, adhering cloſely to the ſame cartilages, and ſupplying to theſe the place of an internal perichondrium.

The fourth membrane is that which completes the circumference of the cartilaginous circles of the trachea. It conſiſts chiefly of two laminae or ſtrata, partly muſcular and partly tendinous; the external or poſterior lamina conſiſting of longitudinal fibres; and the internal, or anterior, of tranſverſe fibres. This membrane is perforated by the ſmall ducts of the above mentioned glands, which diſcharge a fluid when preſſed, and being examined through a microſcope, they appear veſicular or folliculous, much like that of the ſtomach.

The ligaments between the cartilaginous circles are very ſtrong and elaſtic; and each of them is confined to two cartilages, without communicating with any of the reſt, being fixed to the edges of theſe cartilages, much in the ſame manner as the intercoſtal muſcles are inſerted in the ribs.

As the bronchia penetrate into the ſubſtance of the lungs, they gradually loſe their cartilages, till at laſt they become purely membranous; but the muſcular lines of M. Morgagni appear as much, and ſometimes more than before. The two planes, above mentioned, continue likewiſe to be viſible; and we obſerve very diſtinctly, ſometimes even without a microſcope, a great many ſmall holes in the pellicles of the lobuli,

and bronchial veſicles or cells, which open from within outwards

Uſes. Reſpiration is performed by organs of two kinds, one of which may be looked upon as active, the other as paſſive. The lungs are of the ſecond kind, and the firſt comprehends chiefly the diaphragm and intercoſtal muſcles.

As ſoon as the intercoſtal muſcles begin to contract, the arches of the ribs are raiſed together with the ſternum, and placed at a greater diſtance from each other; by which means the cavity of the thorax is enlarged on the two lateral and anterior ſides.

At the ſame inſtant the diaphragm is flatted or brought toward a plane by two motions, which are apparently contrary; that is, by the contraction of the diaphragm, and the dilatation of the ribs in which it is inſerted. The external ſurface of the thorax being thus in a manner increaſed, and the cavity of the bronchia being at the ſame time, and by the ſame means, leſs reſiſted or preſſed upon, the ambient air yields to the external preſſure, and inſinuates itſelf into all the places where the preſſure is diminiſhed; that is, into the aſpera arteria, and into all the ramifications of the bronchia, all the way to the veſicles. This is what is called *inſpiration.*

This motion of inſpiration is inſtantaneous, and ceaſes in a moment, by the relaxation of the intercoſtal muſcles; the elaſtic ligaments and cartilages of the ribs bringing them back at the ſame time to their former ſituation. This motion, by which the ribs are depreſſed and brought nearer to each other, is termed *exſpiration.*

The pulmonary arteries and veins, which accompany the bronchia through all their ramifications, and ſurround the veſicles, tranſmit the blood through their narrow capillary extremities, and thereby change or modify it, at leaſt in three different manners

The

The firſt change or modification which the blood undergoes in the lungs, is to have the coheſion of its parts broken, to be attenuated, and, as it were, reduced to powder. The ſecond is, to be deprived of a certain quantity of ſerum, which tranſpires through the lungs, and is what we commonly call the *breath*. The third is, to be in a manner re-animated by the impreſſion of the air, whether the whole body of the air enters the blood, whether the common air is only the vehicle of ſome finer parts which are conveyed to it, or whether the air only compreſſes and ſhakes the blood as it paſſes round the bronchial veſicles in the reticular capillary extremities of the veſſels.

The cartilages of the aſpera arteria and bronchia ſerve in general to compoſe a canal, the ſides of which will not ſink in or ſubſide by compreſſion, but will nevertheleſs yield to certain preſſures and impulſes without breaking. As theſe cartilages are not complete circles or rings, and as their circumferences are completed by elaſtic membranes, they allow of thoſe dilatations and contractions which modulate the voice; and as they are connected by elaſtic ligaments of a conſiderable breadth, the alternate elongation and contraction of the bronchia is facilitated in the motions of reſpiration.

The larynx is commonly looked upon as the upper part of the aſpera arteria: But we have already deſcribed it in the preceding chapter *of the Head*, with which it has a particular connection in relation to the tongue.

§ 9. *Reſpiration.*

THE lungs completely fill the ſacs formed by the pleura. They are freely ſuſpended by the great blood-veſſels, unleſs you call that a ligament, which is made by the external membrane of the pleura going to the lungs, and to the baſis of the diaphragm. Between the lungs and pleura is found

a watery or rather ſerous vapour, of a coagulable nature, like that of the pericardium; which vapour tranſudes from the ſurface of the lungs continually in the foetus, and not unfrequently in the adult. This is ſometimes increaſed ſo as to form a dropſy, or thickens into a kind of ſebaceous matter; or, laſtly, concreting into fibres, joins the lungs to the pleura.

The veſicles of the lungs do not receive the air by a ſingle orifice from the trachea, as a vial; but the air, exhaling from the leaſt branches of the trachea, is admitted in ſuch a manner into their irregular ſpaces, that it freely ſpreads through them from any one part of the lungs into all the reſt, and returns again in like manner. This is demonſtrated by inflation, which drives the air even through the leaſt branches of the trachea into the ſmalleſt lobes; from whence it readily paſſes into all the reſt. Nor, in man and ſmaller animals, ſays Haller, is the cellular fabric of the intervals ſhut up from the veſicles of the lungs; but according to Sabatier and other late writers, there is no communication between the common cellular ſubſtance and the cells of the lungs.

The air is driven into theſe veſicles through the trachea, which ariſes from the larynx; and in the upper part of the thorax is received between the laminae of the poſterior part of the mediaſtinum.

Its laſt branches are inviſible, which exhale the air into the cellular ſpaces of adult lungs, and likewiſe receive the watery vapours exhaling from the arteries into theſe ſpaces from whence they are thrown by exſpiration.

The quantity of blood which enters into the lungs is exceedingly great, equal to (or even perhaps greater than) that which is ſent in the ſame time throughout the reſt of the body; which, therefore, demonſtrates ſome very conſiderable uſe proper to this viſcus. And that air is concerned in the

uſe

uſe of the lungs, appears from the univerſal conſent of nature, ſince we ſcarce find any animal without breathing; it appears alſo from the ſtructure of the lungs in the foetus, in which, for want of air, they are uſeleſs, receiving only a ſmall portion of the blood, which the pulmonary artery conducts from the heart. We come next, therefore, to ſpeak of reſpiration, *i. e.* the operation by which the air is drawn into, and expelled from the lungs.

The element of air appears from the principles of philoſophy, to be an elaſtic and ſonorous fluid, with a ſpring which cannot be deſtroyed. But the atmoſpherical air, which we commonly receive into the lungs, is impure, filled with a great quantity of watery and other vapours, alſo with ſalts and the univerſal acid, with the ſeeds of plants and animals, and other foreign matters, but in very minute particles; the ſpecific gravity of air 859 times leſs than water, a cubic foot of air weighing between 610 and 694 grains. This air, which ſurrounds the earth on all ſides, being preſſed by the incumbent columns of its own maſs, perpendicularly, laterally, and in all directions, enters forcibly wherever it meets a leſs reſiſtance, as appears from experiments made with the air-pump. Its preſſure upon the human body is not leſs than 3000 pounds weight. It is repelled chiefly by the pores of the membranes, which are yet permeable by water: It likewiſe penetrates oil or mucus with difficulty.

This air is excluded from all parts of the human body by the ſurrounding cloſe ſkin, which, even when dry, is impervious to the air; and, in the living body, the ſkin becomes ſtill more impervious, on account of the fat under it filling the pores. We ſhall next inquire into the reaſon why, and the manner in which the lungs receive air into their ſubſtance; and this inveſtigation becomes the more difficult, when we reflect that the lungs of an adult are always full of air, which, on a ſlight view of the ſubject, we might imagine would

would reſiſt the entrance of a freſh quantity. That the lungs always contain air is evident; becauſe, however cloſe you compreſs them, they will be ſtill lighter than water; and, even in the foetus, after they have been inflated but a few times, they always ſwim; whereas they ſink in water if they have not given admittance to the air.

The equilibrium of the air's preſſure being removed in any place, it conſtantly deſcends or flows that way where it is leaſt reſiſted. But air that is denſe and heavy will deſcend more eaſily than ſuch as is light. Air will not enter the lungs, if it is not ſo denſe as to overcome the force of the air already in the lungs, the reſiſtance of the bronchia, and the preſſure of the lungs themſelves. Hence an animal lives better in a denſe than in a light air; although light air is always more tolerable, if it be at the ſame time pure, than denſe air; ſuch as that of the high mountains of the Alps. That air may enter the lungs, the air which is already in the cellular fabric of the lungs muſt be rarified: But this effect will follow, if the cavity of the thorax, in which the lungs are contained, and which they exactly fill, be dilated. Thus the air, which is always in the lungs, expands into a larger ſpace; by which, being weakened in its ſpring, it makes a leſs reſiſtance to the external air; and conſequently a portion of the external air deſcends into the lungs, ſufficient to reſtore the rarified air in the lungs to the ſame denſity with that of the external air.

In order to dilate the lungs, and thus to induce ſuch a ſtate as that the external air may ruſh into the lungs, it is neceſſary for the thorax to be elevated. By this means, all the ſections of the thorax form right angles, and its capacity is increaſed. This motion is performed by various muſcles, which either operate conſtantly, or only at certain times. The intercoſtal muſcles, therefore, all of them act perpetually in elevating the ribs: But ſome doubt has ariſen about the action

action of the internal intercoſtals; becauſe their lower part is inſerted into that portion of the rib which is neareſt its articulation with the vertebrae, and which therefore ſeems to be the leaſt moveable: However, they nevertheleſs elevate the ribs; for the great firmneſs or immobility of the upper rib, exceeding that of the lower, is evident from the articulation, weight, and ligaments there formed, which ſurpaſſes that mobility, ariſing from the greater diſtance of the centre of motion. This appears from the diſſection of living animals; in which we ſee the inner intercoſtal muſcles operate in the elevation of the ribs, and reſt in the depreſſion of them. It alſo appears, from a flexible thread being fixed to the rib of a human ſkeleton, and drawn in the ſame direction with that of the fibres of the inner intercoſtal muſcles, by which means the lower rib will be always approximated towards the upper. The greater firmneſs alſo of the upper ribs proves this circumſtance, as they ſerve for a fixed point to the lower ones: For the firſt or uppermoſt ribs are from eight to twelve times firmer, and leſs moveable, than the lower true ribs; but the difference of diſtance in them from the centre of motion is ſcarcely the twentieth part of the length of their whole lever. Laſtly, the elevating power of the internal intercoſtal muſcles appears plainly by experiment in a dead ſubject; when, by the thorax being raiſed, the muſcles inſtantly ſwell.

By the action, therefore, of theſe muſcles, the thorax is elevated, not altogether as one machine; nor would reſpiration be aſſiſted by ſuch a motion; but the ribs turning upon their articulations, though behind they are but little moved, yet the fore part of their extremities deſcends, and forms larger angles both with the ſternum and vertebrae; but, from thence, in the middle of their arches, by aſcending, their lower edges are drawn upward; at the ſame time, the ſternum is thruſt out forward more from the vertebrae and from the ribs. Thus the ribs are both removed farther from the ver-

tebrae,

tebrae, and the right ribs from the left; and each diameter of the thorax, *i. e.* the diſtance between the right and left ribs, and the diſtance between the ſternum and the vertebrae, are increaſed almoſt to two lines: And therefore this enlargement, in every imaginable ſection of the thorax, will ſufficiently dilate its cavity. This action of the ribs is more particularly complete in women, and in men who have no ſhortneſs of breath. Theſe effects are produced leaſt of all by the firſt ribs, but more by the following ones. In very ſtrong inſpiration, the ribs deſcend both behind and before; and, along with theſe, the ſternum and ſpaces between the cartilages are leſſened. But this dilatation alone is not ſufficient for healthy breathing; nor is it ſo conſpicuous or evident in men; although in them the intercoſtal muſcles, by retaining and elevating the ribs, very much aſſiſt the inſpiration while they afford a fixed point to the diaphragm, that the whole force of that muſcle may be ſpent, not ſo much in depreſſing the ribs, as in urging down the abdomen. The greater part, therefore, of the ſpace which the thorax gains in inſpiration, ariſes from the action of the diaphragm; the centre of which is more moveable and at liberty than the reſt; except in the middle of its tendinous part near the fleſhy margin, where the incumbent heart makes a reſiſtance; but the lateral parts and the fleſhy portions belonging to them are the moſt moveable.

There are two holes in the diaphragm; of which that on the right ſide of its tendinous part its ſomewhat ſquare, and circumſcribed by four ſtrong tendinous portions; the left, which is elliptical, lies between the right and left fleſhy portions, which ariſe from the middle of the bodies of the vertebrae of the loins: Under this opening they decuſſate and croſs each other once or twice, but above they end in the tendon. This left opening is therefore drawn cloſe together in the contraction of the diaphragm, while it is probable that the

the other opening remains immoveable. The tendons are but little changed in the motion of the muſcles.

The ſtructure of the parts, and the diſſection of living animals, demonſtrate, that the fleſhy portions of the diaphragm, which on all ſides aſcend from the firm parts to the middle and more moveable, do, by their contraction, depreſs the middle, and by that means draw down the lateral bags of the thorax, which contains the lungs; and, by this means, the perpendicular diameter of the thorax is conſiderably increaſed. The fleſhy parts are more depreſſed; the tendon leſs; both becauſe it is fixed to the pericardium, and becauſe its own ſubſtance does not contract. Even the oeſophagus and vena cava are contracted, while the diaphragm exerts its action. So that the diaphragm almoſt alone performs the office of reſpiration in a healthy man at reſt. The diaphragm is alſo the chief inſtrument of reſpiration in the caſe of fractured ribs or ſternum, or where the ribs cannot be moved without exciting conſiderable pain. The force of the diaphragm alſo, in dilating the breaſt, is greater, according to the calculations that have been made, than all the reſt of the powers which contribute to reſpiration. A great inſpiration is ſomewhat hindered; becauſe, during the greateſt exertion of the diaphragm, the lowermoſt ribs are brought inwards, and thus the thorax is ſtraightened. Leſt this ſhould always happen, the intercoſtal muſcles interfere in ordinary inſpirations; in the very great ones, they are inferior to the diaphragm. The phrenic nerve, which is more eaſily irritated than in moſt other muſcles, forces the diaphragm to perform its office. The lungs themſelves are altogether paſſive or obedient to the action of the air; and alſo to that of the ribs and diaphragm, to which they are preſſed into cloſe contact on all ſides; and we ſometimes ſee them even preſſed through a large wound of the thorax; and ſometimes when the cavity

is whole, we ſee them through the tranſparent pleura, and part of the diaphragm.

But, in larger inſpirations, when a greater quantity of blood is driven into the lungs, and when there is any obſtacle or difficulty oppoſed to the action of the lungs themſelves; in thoſe caſes, ſeveral other powers conſpire to elevate the thorax. Which powers are inſerted either into the thorax, clavicles, or ſcapulae; ſuch as the ſcaleni muſcles, trapezii, cervicales deſcendentes, ſerrati ſuperiores, and pectorales; together with the ſmall elevators.

We have now deſcribed the powers which are able to increaſe the capacity of the thorax in all its three dimenſions. By theſe the cavity of the breaſt is dilated, ſo that it compreſſes the lungs leſs than before: The lungs then ſtrive to diffuſe themſelves over that ſpace, by the expanſion of the air contained in them, when the preſſure is removed. Without the muſcular force, the lungs have no proper power of their own, by which they are capable of attracting air. Even when they are full of air, if the aſpera arteria be cloſed, the animal vehemently attempts to inſpire, by the efforts of its intercoſtal muſcles and diaphragm. The air which is preſſed on all ſides by the incumbent columns of the atmoſphere, enters the thorax with the greater force, in proportion as the lungs contain leſs air; and yet more powerfully if they contain no air; but with no force at all, if the air admitted through a wound in the breaſt preſſes upon the external ſurface of the lungs. In this action, therefore, which is called inſpiration, the bronchia are every way increaſed, both in length and diameter; becauſe all the diameters of the thorax are increaſed; and the inflated lungs always keep contiguous to the pleura, without leaving any intermediate ſpace. At the ſame time, the pulmonary blood-veſſels being contained in the ſame cellular covering with the bronchia, are, with them, extended in length, and ſpread out into larger angles; by which means the

the circulation through them is rendered eaſier. While this is performing, the veſicular ſubſtance, or fleſh of the lungs themſelves, filled with air, increaſes thoſe ſpaces through which the capillary blood-veſſels of the lungs advance; whereby the veſicular preſſure upon each other, and upon thoſe veſſels adjacent, is leſſened. Thus, therefore, the blood will flow with greater eaſe and celerity into, and through, the larger and ſmaller veſſels of the lungs. Hence a dying animal is revived by inflating its lungs, and facilitating the paſſage of the blood to the left ventricle of the heart; and thus people, ſeemingly dead by being kept a long time under water, are again recovered. The preſſure of the air upon the blood in the lungs, in this action, is ſo inconſiderable as not to deſerve our notice, being at leaſt 300 times leſs than the force of the heart, and can never urge the air into the blood.

Some anatomiſts ſuppoſe, that a quantity of air is contained between the lungs and the ſides of the thorax; and that this air is contracted during inſpiration, and being again expanded, preſſes the lungs, and cauſes exſpiration. They ſupport their opinion by producing inſtances of birds where this fact undoubtedly obtains. But we ſee every thing concurs to confute theſe opinions with reſpect to man and quadrupeds, &c.; for, immediately under the pleura, in living quadrupeds, as well as in dead human bodies, the lungs are viſible, without any intermediate ſpace between them; but the pleura being perforated, the lungs are immediately, by the contiguous air that enters, preſſed together towards the vertebrae. In birds, indeed, the lungs being pervious to the air, admit it into the cavity of the thorax through large holes in their ſubſtance. But in theſe animals there is a manifeſt ſpace between the lungs and the pleura. Large wounds, admitting the air only into one cavity of the thorax, diminiſh the reſpiration; but, ſuch wounds as let the air into both cavities, quite ſuffocate or ſuppreſs the reſpiration. The thorax being opened under

under water, ſends out no bubbles of air through the water; but, in birds, it does, becauſe they have air in their thorax. If there ſhould accidentally be any ſpace between the lungs and the thorax, it is always filled up by a watery or ſerous vapour, or elſe by the ſame vapour condenſed into a watery lymph. If the lungs adhere, they injure the reſpiration but in a ſmall degree, which ought entirely to ceaſe, if it required an intermediate air between the lungs and thorax. Finally, the external air being admitted to any of the internal membranes of the human body, deſtroys their texture, if they are not defended by a plentiful mucus; of which we can find none upon the ſurface of the pleura.

But reſpiration, whether by the admixture of a ſub-putrid vapour, or by ſome other method, certainly vitiates the air, and renders it unfit either for inflating the lungs or ſupporting flame; and laſtly, it deprives that element of its elaſticity. We may ſuppoſe that this happens from putrefaction, ſince the air is rendered peſtilential by a crowd, and fevers of the moſt malignant kind are thus generated in a few hours. But, in whatever manner this is produced, we are certain that the air is vitiated in the lungs, loſes its elaſticity, and thus cannot keep the lungs diſtended, ſo as to tranſmit an increaſed quantity of blood through the dilated pulmonary arteries into the veins. Nor can the will dilate the breaſt beyond certain bounds, or aſſiſt that paſſage of the blood in an unlimited manner. A ſtate of body, therefore, will take place, in which the blood cannot paſs through the lungs.

Thus is generated a new reſiſtance to the blood continually coming from the heart: And in long retentions of the breath, as in making violent efforts, the venous blood, eſpecially that coming from the head, ſtagnates before the right ventricle of the heart, which is ſhut, becauſe it cannot evacuate itſelf into the lungs, and thus ſwells up the face with redneſs, ſometimes burſts the veins of the brain, neck, inteſtines,

tines, kidneys, and laſtly of the lungs, and even right auricle of the heart. This ſtagnation of the blood occaſions prodigious anxiety and uneaſineſs to the ſpirits; it is alſo the cauſe of death in compreſſed air, in drowned people, and ſuch as are ſtrangled, which is much more ſudden than is commonly imagined. A living perſon, therefore, that he may remove thoſe inconveniencies which proceed from an obſtruction of the paſſage of the blood, ſlackens the powers of inſpiration, and excites thoſe of exſpiration, which free the breaſt from an air too greatly rarified.

Theſe powers are, firſt, the elaſticity of the ribs; which, being drawn upwards out of their natural ſituation, as ſoon as the powers which elevated them ceaſe to act, ſpontaneouſly place themſelves, ſo as to make more acute angles with the ſternum and vertebrae. To this end conduces likewiſe the elaſtic force of the bronchia and veſicles diſtended with air, which ſtrive to contract themſelves. Hence exſpiration is performed more eaſily and quickly than inſpiration; and hence it is the laſt action of dying people.

The abdominal muſcles all contribute to contract the thorax. The recti, which are fixed to the oſſa pubis by one end, and to the lower ribs by the other, being contracted, depreſs the arch or convexity, into which the abdominal viſcera are thruſt by the diaphragm: At the ſame time the abdominal viſcera are preſſed by thoſe muſcles upward and backward againſt the diaphragm, which alone is able to give way, and yield toward the thorax, which at that time is rendered ſhorter. The obliqui, for the ſame reaſons, compreſs the lateral parts of the abdomen, and urge the liver and ſtomach backwards, and preſs them towards that place where there is the leaſt reſiſtance. Laſtly, they draw down the ribs which were before elevated by the intercoſtals. The tranſverſales, indeed, do not draw the ribs; but they pull the cartilages of the falſe ribs a little inward, and render the whole capacity

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of the abdomen leſs, while at the ſame time they preſs the viſcera againſt the diaphragm. Along with theſe we may reckon the powers of the ſterno-coſtal and long intercoſtal muſcles, which are called *depreſſores*. By this joint force the ſuperior ribs deſcend; but the middle ones more, the uppermoſt leſs, the loweſt moſt of all; and their margins being brought inward, the cartilages aſcend, and return into acute angles with the ſternum, and the ſternum itſelf returns backwards with the ribs. By theſe means the thorax, contrary to its former ſtate, is every where rendered narrower and ſhorter, ſo as to expel as much air out of the lungs as is ſufficient to relieve the uneaſineſs cauſed by its retention.

In more powerful reſpirations, when the inſpirations are made greater, the exſpirations are likewiſe increaſed by the aſſiſtance of ſome other powers, as of the ſacrolumbalis, longiſſimus, and quadratus muſcles of the back and loins. This force, by which the air is blown out of the lungs, is ſufficient to carry a leaden bullet, weighing about a dram, to the diſtance of 363 feet; which force is equal to a third part of the preſſure of the atmoſphere. But, in a healthy perſon, the muſcles of the abdomen alone produce an eaſy exſpiration, in which the lungs are not ſo much emptied of air as they are by a violent efflation.

The effects of exſpiration are, a compreſſure of the blood-veſſels in the lungs, a reduction of the bronchia into more acute angles, a preſſure of the reticular ſmall veſſels by the weight and contact of the adjacent larger veſſels, and an expulſion of the corrupted air from the lungs; by which means part of the blood adhering in the capillary arteries, is urged forward through the veins to the left ſide of the heart, while at the ſame time that part of the blood is reſiſted which flows in by the artery from the right ventricle. Exſpiration, therefore, will ſtop the eaſy paſſage of the blood through the lungs; and when the whole thorax is compreſ-

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ſed together, repels the venous blood into the veins of the head, and fills the brain and its ſinuſes.

The inconveniencies produced by exſpiration, excite new efforts for repeating the reſpiration; becauſe the collapſed veſſels of the lungs reſiſt the blood expelled from the right ventricle of the heart. Hence the cauſe of death in thoſe animals which expire in veſſels exhauſted of air: For their lungs being void of air, become denſe, ſolid, and heavier than water, whence they are rendered impervious to the blood. Of the ſame kind is the death of thoſe who are killed by lightning, and, perhaps, by the noxious vapours of caverns. How admirable are the ſtructure and mechaniſm in theſe organs of reſpiration! The uneaſy ſenſations of a too long continued exſpiration, which ariſe from hindrances of the blood's paſſage through the lungs, excite into action the powers of inſpiration, whereby the blood's paſſage through the lungs is rendered again more free and eaſy; and, *vice verſa*, the uneaſineſs proceeding from a too long continued inſpiration, excite the powers of exſpiration.

It is queſtioned by ſome authors, Whether or no there are not other cauſes of alternate reſpiration? Whether or no we may hope for any diſcovery in this matter by compreſſing the vena ſine pari, the phrenic nerve, or intercepting the blood ſent to the brain? But theſe opinions are repugnant to comparative anatomy, by which we always find the ſame alternation in the breathing of the animal, independent of any ſuch nerve or vein. Whether or no reſpiration is from the alternate contraction of the antagoniſt muſcles, among which thoſe of exſpiration relax the others of inſpiration, and the reverſe? This doctrine ſeems improbable, becauſe all the muſcles of the human body are perpetually in an alternate motion.

From what has been hitherto ſaid, it appears, that reſpiration is unavoidably and abſolutely neceſſary to life in a healthy

healthy adult perſon; becauſe, whether the lungs remain long in a ſtate either of exſpiration or inſpiration, we ſee death will ſoon be the conſequence. No animal, therefore, that has lungs like ourſelves, after it has once breathed, and received the air into the inmoſt parts of the lungs, and by that means brought a new and large quantity of blood to that viſcus, can ſubſiſt longer than a few minutes without the uſe and benefit of a free air; but it will either periſh, or at leaſt fall into ſuch a ſtate as differs from death only in its being recoverable again by certain powers or actions. In an animal lately born, this neceſſity for air does not take place ſo ſuddenly.

But the uſe of reſpiration is different from this neceſſity; which nature might have avoided, either by uſing no lungs at all, or elſe by diſpoſing them in a manner reſembling thoſe of the foetus. This uſe, therefore, of reſpiration muſt be very conſiderable, ſince all animals are either made with lungs, or with gills, as in fiſh, or elſe with a trachea diſperſed through all parts of the body.

In order to diſcover this uſefulneſs of reſpiration, let us compare the blood of an adult perſon with that of a foetus, and alſo with the ſame vital fluid in fiſhes. It appears then in a foetus, that the blood is deſtitute of its florid redneſs and ſolid denſity; and in the blood of fiſhes, we obſerve there is no heat, the denſity inconſiderable, and but little craſſamentum contained in it; and therefore we are perſuaded, by the nature of theſe circumſtances, that the blood acquires all theſe properties in the lungs.

It may be aſked, therefore, Whether the blood does not acquire its heat principally in the lungs? But this does not ariſe from the alternate extenſion and contraction, relaxation and compreſſion, of the pulmonary veſſels, by which the ſolid parts of the blood are perpetually rubbed and cloſely compreſſed. The lungs, therefore, will add to the office of the

the reſt of the arteries, becauſe in them the blood is alternately relaxed and compreſſed, more than in any other part of the body. But even when the lungs are obſtructed, ulcerated, and almoſt deſtroyed, a morbid heat ſeizes upon the body; and in the lungs the cold air very near touches the blood.

The denſity of the blood is ſomewhat increaſed in the lungs, by the copious diſcharge of the watery vapour which is there ſeparated, by which the reſt of the maſs becomes ſpecifically heavier. But the ſame effect ſeems to follow here as in other arteries, namely, from the attrition and preſſure which the blood here ſuffers in being alternately retarded, accelerated, and figured in its courſe through the modulating tubes of the leaſt veſſels, which gives a roundneſs and denſity to the particles; hence it becomes denſer, as having more of the weighty globules, and leſs of the lighter fluid. And, in this reſpect, the pulmonary vein being ſmaller than its correſponding artery, is of no ſmall uſe towards increaſing the attraction of coheſion between the parts of the globules, ſo as to compreſs and bring them cloſer to each other. Nevertheleſs, cold animals, which have very ſmall lungs, have denſe and coagulate blood; as alſo a chicken before it is hatched. The blood alſo has a ſhort paſſage through the lungs: The paſſage through the whole body is longer, and the artery weaker; the ſide of the heart, by which the blood is driven forward, is alſo weaker.

It is queried by ſome anatomiſts, Whether the air itſelf is not received by the blood in the lungs, ſo as to excite neceſſary vibrations therein? Whether this does not appear from the reſiſtance of bodies to the heavy external air; from the air found in the blood-veſſels, in the cellular ſubſtance, and in certain cavities of the human body; from the cracking obſerved by an extenſion of the joints; from air manifeſtly extravaſated from the trachea into the hearts of certain ani-

mals, as in the locuſt; from our being able to extract air out of the blood and humours of animals in vacuo; from a neceſſity of a vital oſcillation in the blood itſelf; and, laſtly, from the increaſed redneſs of the pulmonary blood?

But that no elaſtic air is here received into the blood, is demonſtrated, from the impoſſibiltty of forcing air into blood, if it retains its elaſticity; from the inutility of its reception, if the ſpring of it ſhould be loſt in the blood, from the perfect immutability of the blood by cold; from the minuteneſs of the inhaling veſſels; from the mucus that perpetually lines the ſides of the veſicles in the lungs; from the nature of the elaſtic air itſelf, which is very unapt to paſs through capillary veſſels; from a repulſion of it by water, for it is hindered from paſſing through paper, linen cloth, or ſkins, when they are wet. Again, the air taken in by the trachea never paſſes to the heart; or whenever it does ſo, it is forced thither by ſome great or unnatural violence: But the permanent air in the veſſels and humours of the human body, from a ſtate of inelaſticity, may become elaſtic by putrefaction, froſt, or an external vacuum. Such permanent unelaſtic air is incorporated with all liquors, and taken into our bodies with the aliments, and with abſorbed vapours, mixing ſlowly and with ſome difficulty. But there never were any elaſtic bubbles of air obſerved in the blood of a living animal: and ſuch air being inflated into the blood-veſſels of any living animal, certainly and ſpeedily kills it. Laſtly, though air, indeed, is abſorbed by moſt of our humours, yet that abſorption is performed ſlowly, and takes up the ſpace of ſeveral days after the former air has been exhauſted by the pump. It then likewiſe lays aſide its elaſtic nature; nor are there any reaſons why the air ſhould either be more ſpeedily abſorbed by the blood, or why it ſhould retain its elaſticity after it is ſo abſorbed.

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" If, in a few words," ſays Dr Wriſberg, " I might offer my opinion about the air found in our bodies, the origin of which has been the baſis of ſo many diſputes, I am perſuaded that the atmoſpheric air is a very compound fluid, conſiſting of parts of a very different nature and quality, which parts, when mixed with any primogenial fluid as a vehicle, make the common air we inhale in inſpiration. This primogenial fluid is, perhaps, that air which we obſerve in animals, vegetables, and likewiſe in the earth itſelf, differing only according to the various ſubſtances with which it is united. If there is mixed, in a due proportion with this univerſal fluid, any elaſtic, ethereal, electric principle, or any particles not yet fully underſtood, perhaps there will reſult ſalubrious atmoſpheric air. But it will become infected and noxious in various degrees, from an admixture of putrefactive ſubſtances, narcotic or inflammable ſuffocating elements. For that reaſon it ſeems to me very proper, that our judgment about the ſalutary or noxious quality of the air ſhould be directed by theſe principles; and we ſhall be able to correct unwholeſome air, provided we know what qualities that air ſhould poſſeſs which is moſt properly ſuited to reſpiration.

Is the blood cooled in the lungs? Is this opinion confirmed by the death of animals in too great a degree of heat? Are not the pulmonary veins leſs than the arteries? Is this the reaſon why laborious people prefer cold? That the blood is cooled in the lungs is thus far true, as it warms the contiguous air, and therefore loſes ſomething of its own heat. That this was not the principal deſign of nature, is evident from the well known fact, that the venous blood is not hotter than the arterial; and nobody ever obſerved the left ventricle of the heart cooler than the right. Beſides, a perſon may live in an air much hotter than the blood itſelf, of which we have examples in baths and warm countries. In a foe-

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tus which does not reſpire, the right auricle and ventricle of the heart, and alſo the pulmonary artery, are much greater in proportion than in an adult, which ſeems neceſſary to reſerve and retard the blood.

Is the redneſs of the blood produced by the air? This ſeems alſo to be contradicted by the well known fact obſerved in frogs, that the redneſs of their blood is in proportion to the quantity of food they uſe. Beſides, we have before ſhewn that the air does not come into immediate contact with the blood in the lungs. We cannot, however, deny that, when the air comes into immediate contact with the blood, its redneſs is increaſed, and its colour becomes again pale when the air is excluded. It ſeems probable, from analogy, that, as light produces colour in vegetables, ſome ſubtle principle, imbibed by the blood from the air received into the lungs, may be the cauſe of its red colour.

Does blood, by means of the lungs, abſorb nitre from the air? Or is the florid colour, obſervable in the ſurface of a cake of blood, owing to the abſorption of nitre from the air, while the bottom parts are of a dark and blackiſh colour? If any thing be abſorbed, is it a preſervative againſt the putrefaction of the animal? Dr Haller ſhews the abſurdities of theſe ſuppoſitions, by chemical reaſoning and experiment. What he advances would have been acknowledged as a complete refutation of the doctrine, according to the received ſyſtem of chemiſtry at the time he wrote. But, laying all chemical reaſoning aſide, the opinion will be found to be altogether unſupportable, by attending to the following fact, with which, indeed, Dr Haller cloſes his refutation. No nitrous ſalt is diſcovered in the blood.

If it be aſked, Why tortoiſes, frogs, lizards, ſnails, and ſeveral inſects, live long without air? we anſwer, That in them the lungs are given, not ſo much for the preparation of the blood, as for the uſe of ſwimming: And from

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hence it is that their lungs, which receive only a ſmall quantity of blood, are immediately joined with the vena cava and aorta. But inſects, we know, draw the air in, and exhale it again, through pores in the ſkin If it be aſked, Why all animals periſh in air that is not renewed? we anſwer, Becauſe the air which has once entered the lungs, and been contaminated by watery al- -leſcent vapours, is rendered leſs elaſtic, and conſequently unfit for reſpiration: Not becauſe it becomes lighter; for the mercury falls but little in air which has not been renewed, and which has killed an animal. Hence it is that the animal ſurvives longer in air that is denſer than the atmoſphere in its uſual ſtate; for in that caſe there is a greater proportion of the elaſtic element, which takes up a longer time to corrupt. Even in other caſes, confined air is rendered deſtructive only by ſtagnation, and filling it with vapours The reaſon why animals ſwell in an exhauſted receiver is, from the extrication of the unelaſtic air lodged in the blood and other juices.

Reſpiration ſeems ſomehow to agree with the pulſation of the heart, there being ordinarily three or four pulſes to one reſpiration. And, if a greater quantity of blood is ſent to the heart in a given time, the numbers both of the pulſe and reſpiration are increaſed. This is the reaſon of the panting or ſhort breathing, after exerciſe, or any conſiderable motion, which increaſes the return of the blood to the heart. If the blood meets with a reſiſtance in the lungs, ſo that it cannot paſs freely from the right into the left ventricle of the heart; then the reſpiration is increaſed, both in quickneſs and magnitude, in order to forward its courſe: And this is the cauſe of ſighing, yawning, and panting; of which the firſt is a deep inſpiration; the ſecond a ſlow and very great one; and the third, a frequent and imperfect one. The number of reſpirations, however, does not always increaſe with the pulſe,

pulſe, as we ſee in thoſe fevers where the lungs are not affected.

The mucus, which lines the ſenſible membranes of the air-veſſels in the lungs, may become troubleſome, both by its quantity and acrimony; it has been known to cauſe even ſuffocation in a dropſy of the lungs. Its quantity, adheſion, or acrimony, therefore, excite a cough; which operation, cauſed by an irritation of the organs of reſpiration, is performed by alternate large inſpirations, ſucceeded by large and quick exſpirations, together with ſudden ſhocks of the abdominal muſcles; and by theſe means the mucus, and ſometimes calculous matters, are expelled from the lungs.

Laughter differs from coughing in its cauſe, which reſides commonly in the mind, or at leaſt conſiſts in a certain titillation of ſome of the cutaneous nerves; and alſo in its action, which is one large inſpiration ſucceeded by ſeveral imperfect quick exſpirations through the contracted glottis, the lungs being never totally evacuated of air. Hence laughter, in a moderate degree, conduces to health; becauſe, inſtead of one full inſpiration, many ſhort inſpirations and exſpirations happen, and thus the concuſſion is greater. Hence its danger of ſtagnating the blood; becauſe the exſpiration is not full or entire, and the blood is admitted into the pulmonary artery without being ſuffered to paſs through it. Weeping begins with a great inſpiration, after which follow ſhort alternate inſpirations and exſpirations; and it is finiſhed with a deep exſpiration, that is immediately joined by a large inſpiration: Hence it has nearly the ſame good and bad effects; and, when moderate, it conduces to relieve the anguiſh ariſing from grief. An hiccup is a very great, ſonorous, and ſudden inſpiration. Sneezing conſiſts of one large or deep inſpiration, which is followed immediately with a powerful and ſudden exſpiration; it evacuates with great violence any acrid or other ſubſtance irritating the noſtrils.

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The ſecondary uſes of reſpiration are very numerous. It abſorbs from the blood ſome noxious particles which might perhaps ſuffocate, if they were ſuffered to remain. Thus, the breath of many people, ſhut up in a cloſe place, impregnates the air with a ſuffocating quality. And the blood abſorbs from the air a thin vapour, of which the uſe is perhaps not yet ſufficiently known*.

" Among the various uſes of reſpiration, (ſays Wriſberg,) all of which, indeed, are of conſiderable conſequence, we may eſteem as a principal one, the abſorption of ſome parts of the atmoſphere more peculiarly adapted to the ſupport of life. The lungs perhaps ſeparate, in conſequence of their peculiar ſtructure, this vivifying principle from the other conſtituent elements of the atmoſphere, and, through proper veſſels, convey it, thus ſeparated, into the circulating maſs.

" This ſubſtance has not as yet received any proper name†, nor do we ſufficiently know its nature and properties. The denomination *pabulum vitae*, given to it by the celebrated Ray, ſeems to accord tolerably well with its nature; for, when it was exhauſted from the air by animals breathing in cloſe veſſels, ſuch animals inevitably died, unleſs a freſh quantity of atmoſpheric air was introduced into the veſſel. The name of *electric principle* ſeems more fitly adapted to the ſubſtance. By the obſervations of Gilbert, Guericke, Boyle, the Florentine academicians, Hawkſbee, Du Fay, Muſchenbroek, Watſon, Ludolph, Winckler, Nollet, Franklin, Hartman, Prieſtley, and ſeveral others, both on the electricity of bodies in general, as well as of the atmoſphere in particular, our knowledge of it has been much increaſed; and, by the experiments of Wilſon, Volla, Wilkens, Gallitzin, Lichtenberg, and others, it may ſafely be aſſerted that the electric matter of

* See a clear expoſition of this ſubject, in the note, p. 289. of this volume.

† Subſequent phyſiologiſts have at length aſcertained the true nature of this ſubſtance; and the French philoſophers have very appoſitely called it *vital air* or *oxygen*. It was known to the Engliſh philoſophers by the name *dephlogiſticated air*.

of the air is collected in the moſt ſimple manner by almoſt every body. From all theſe experiments we collect,

" 1. That there is in the air a fluid which, in different ways, may be increaſed in one place, and diminiſhed in another; which, when collected by proper machines, exhibits electric ſparks; but, when collected in the clouds, breaks forth in thunder and lightning.

" 2. If from its two great congeſtion, in any region of the atmoſphere, or in the clouds, the circumambient air wants its due proportion, our reſpiration is leſs refreſhing, and our ſtrength grows languid; but they are quickly renewed after a thunder ſtorm, the equilibrium of the electric matter in the atmoſphere being reſtored, as it were, by the flaſhes of lightning.

" 3. Perhaps we may at length arrive at the knowledge of ſome artificial means by which we may be able to ſupply this defect of electricity in the atmoſphere. A farther inveſtigation of this ſubject may perhaps be not altogether uſeleſs.

" 4. This electric matter paſſes into the blood or lymph by innumerable pores and foramina, with which the inſide of the larynx, aſpera arteria, and bronchia, abound. Upon the diverſity of theſe holes, both with reſpect to the number, condition, and the mucus with which they may be covered, and to the ſize of the lungs, depends the reaſon why all men cannot inhale and abſorb the ſame quantity of electric matter from one and the ſame air.

" 5. As ſufficient obſervations on this new ſubject have not yet been made, it is difficult to determine what uſe this ſubſtance ſerves in animal bodies, and what functions depend upon it. Is the tone and irritability of the fibres of the body principally ſupported by it? Do the cauſes of animal heat proceed from it? The animal electricity, which is very conſpicuous in cats, horſes, and alſo in men, by the numerous ſparks ſeen to iſſue from their bodies, probably proceeds

proceed from the electricity abſorbed by the lungs from the air. This is perhaps the cauſe of the greater danger to which ſome men are liable of being ſtruck with thunder than others. The ſpontaneous burning of ſome natural bodies, is undoubtedly to be aſcribed to the ſame cauſe; and the alacrity and vigour of ſome temperaments are wonderfully increaſed by the preſence of this fluid. May this ſubſtance be joined with the acidum pingue and inflammable principle *?

Some of the ſecondary uſes of reſpiration are to compreſs the abdominal viſcera, ſo that the ſtomach, inteſtines, gall-bladder, receptacle of the chyle, bladder, inteſtinum rectum, and the womb itſelf, may diſcharge their contents; that the aliments may be triturated or diſſolved, and the blood urged through the ſluggiſh veſſels of the liver, ſpleen, and meſentery. Reſpiration excites a kind of flux and reflux in the blood, ſo that it is alternately preſſed back towards the extremities of the veins, and a little after is propelled towards the heart by an accelerated velocity. Moreover, inſpiration ſerves to convey odours along with the air to the organ of ſmelling; and is alſo the principal means by which a new born infant is enabled to perform the operation of ſucking.

§ 10. *Oeſophagus.*

Situation and figure. The oeſophagus is a canal partly muſcular and partly membranous; which commences at the inferior part of the pharynx, and deſcends along the neck and back part of the thorax, into the abdomen. While it lies in the neck, it is placed between the middle and left part of the cervical vertebrae behind the left part of the trachea; in the thorax it is ſituated between the layers of the poſterior mediaſtinum, and deſcends to the fourth or fifth vertebra of the

* This doctrine of Dr Wriſberg's is extremely hypothetical.—Since the former editions of this work were publiſhed, the actual changes which take place in the reſpired air, and on the blood, in the lungs during reſpiration, have been aſcertained, in conſequence of the modern chemical diſcoveries.

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back, in the ſame direction which it had above: There it inclines a little from left to right, till it reaches the ninth rib, to make way for the aorta; afterwards it inclines from right to left, and from behind forward, to get through the diaphragm into the upper orifice of the ſtomach.

Structure and coats. It is made up of ſeveral coats, almoſt in the ſame manner as the ſtomach, of which it is the continuation. The firſt coat, while in the thorax, is formed only by the duplicature of the poſterior part of the mediaſtinum, and is wanting above the thorax and in the neck, where the outer coat of the oeſophagus is only a continuation of the cellular ſubſtance belonging to the neighbouring parts.

The ſecond coat is muſcular, being made up of ſeveral ſtrata of fleſhy fibres. The outermoſt are moſtly longitudinal, and their quantity is much greater than that on the reſt of the alimentary canal; but they are not all continued from one end of the oeſophagus to the other. The following ſtrata are obliquely tranſverſe, and the innermoſt are turned a little obliquely the contrary way. They croſs each other irregularly in many places, but are neither ſpiral nor annular.

The third is termed the *nervous coat*, and is like that of the ſtomach and inteſtines. It is differently folded or plaited, according to its length, being much wider than the muſcular coat; and it is ſurrounded by a whitiſh, ſoft, fine filamentary ſubſtance, like a kind of cotton, which, when ſteeped in water, ſwells and grows thicker.

The fourth or innermoſt coat reſembles, in ſome meaſure, that of the inteſtines; except that, inſtead of the villi, it has ſmall and very ſhort papillae. It is folded lengthwiſe like the third coat; ſo that the oeſophagus, when cut acroſs, repreſents

The atmoſpheric air, before inſpiration, is known to conſiſt of one-third part nearly of oxygen gas, mixed with two-thirds of azot. After expiration, moſt of the oxygen is no longer to be found, having combined, within the lungs,

ſents one tube within another. Through the pores of this coat a viſcid lymph is continually diſcharged.

The upper end of the oeſophagus is ſupplied with arteries from the laryngeae inferiores; farther down it has branches from thoſe which ſupply the pericardium; the reſt of it is ſupplied by the arteriae bronchiales. The veins go into the ſuperior laryngeals, to the top of the ſuperior vena cava, to the vena azygos and bronchial veins.

The nerves are chiefly from the eighth pair; but ſome ſmall branches come from the great ſympathetics.

§ 11. *Ductus Thoracicus.*

This duct, and its ſituation in the thorax, is deſcribed in Volume third, along with the lymphatic ſyſtem.

CHAP.

lungs, with a quantity of carbon, derived from the venous blood in the pulmonary arteries, by which carbonic acid is formed, and which is expired along with the azotic gas: The expired air being no longer capable of ſuſtaining life or flame.

Thus, during reſpiration, an actual ſlow combuſtion takes place in the air cells of the lungs, by which the dark venous blood is deprived of its over-abundant carbon, and reſtored to the ſtate of florid arterial blood, again to circulate through the body, and perhaps carries with it a part of the oxygen and ſome of the azot. It may be likewiſe, that ſome hydrogen, from the venous blood, combines with part of the inſpired oxygen, to form part of the aqueous vapour which is expired.

During the ſlow combuſtion, which reſpiration certainly operates, of the carbon and oxygen, a quantity of caloric is diſengaged from the later, and heat is produced. To this ſource, in a great meaſure, is to be attributed the origin and ſupply of animal heat; as this is found greatly deficient where malconformation or diſeaſe prevents the free pulmonary circulation of the blood.

The proper illuſtration of this curious and important ſubject in phyſiology and pathology would lead to lengthened diſcuſſion, for which there is not room in this work, and for which the preſent ſtate of chemical knowledge does not ſupply ſufficiently accurate materials. Let philoſophers beware, in overturning one groundleſs hypotheſis, how they ſubſtitute others without proper foundations. An accurate ſeries of experiments, on the changes which reſpiration produces in the blood and air within the lungs, is much wanted, and will give long during and well merited fame to its author.

CHAP. III.

OF THE ABDOMEN.

THE whole fore part of the abdomen forms an oblong convexity like an oval vault, more or leſs prominent in the natural ſtate, in proportion to the quantity of fat upon it, and the food contained in it; or to the different degrees of pregnancy in women. The hypogaſtric and umbilical regions are more ſubject to theſe varieties than the epigaſtric.

On the ſides, between the hypochondria and os ilium, the abdomen is generally a little contracted; and backward, about the middle of the regio lumbaris, it is gently depreſſed, forming a kind of tranſverſe cavity, anſwering to the natural incurvation of the lumbar portion of the ſpina dorſi.

This anterior convexity, and poſterior cavity, change as we ſit, ſtand, kneel, lie at our full length, or with the thighs bent; and theſe variations depend on the particular ſituation of the oſſa innominata in theſe different poſtures.

In ſtanding, the convexity of the belly, and cavity of the loins, are more conſiderable than in moſt other ſituations; for then the lower extremity of the os ſacrum is turned very far back, and conſequently the os pubis very much down. In this ſituation of the pelvis, the inteſtines fall naturally forward, and thus increaſe the convexity of the abdomen; and, as the vertebrae of the loins are very much bent at the ſame time, the cavity in that place muſt likewiſe be very conſiderable.

In

In kneeling, the ossa pubis are still lower than when we stand: And this not only increases the hollow of the loins, and throws the abdomen and its viscera more outward or forward, but also in some measure strains the abdominal muscles; which is so uneasy to some persons, as to cause fainting.

This depression of the os pubis in kneeling depends partly on the tension of the two musculi recti anteriores; the lower tendons of which are, in this situation, drawn with violence under the condyloid pulley of the os femoris.

When we sit in the common manner, that is, with the thighs stretched out in a plane parallel to that of the seat, the convexity of the belly and hollow of the loins diminish.

For the pelvis being in this situation supported on the tubercula ischii, and these tubercles being very near the fore-part of the pelvis, the trunk of the body pressing on the os sacrum must lower the pelvis behind, and raise it before.

When we lie upon the back at full length, and with the thighs extended, the belly is less convex, but more stretched and hard; whereas, when the thighs are bent, it is soft and lax. In this situation, the regio lumbaris is almost flat, and very little depressed.

When we lie on the back, and raise the head, or endeavour to raise it, we feel a tension in the fore-part of the abdomen, which increases in proportion to the force we use in raising the head.

Integuments of the abdomen. The skin on the anterior portion of the abdomen is thinner and more compact than the posterior, and it has likewise the peculiar property of being capable of receiving a considerable increase in breadth, and sometimes in a very extraordinary manner, without losing any of its thickness, in proportion to what it gains in breadth.

The cells of the membrana adiposa, which covers the convex part of the abdomen, are disposed in a very regular manner,

ner, as we discover by dissecting the skin from the muscles; for then there appears on the inner surface of the membrana adiposa a longitudinal line like a kind of raphe, produced by the meeting of the cellular rows, which form angles successively, one above another, opposite to the linea alba of the abdomen. The cells in these rows are more oblong than the rest, and in a manner oval, or like a grain of wheat.

Cavity of the abdomen. The appendix ensiformis of the sternum, the cartilaginous portions of the last pair of true ribs, those of the first four pairs of false ribs, all the fifth pair, the five lumbar vertebrae, the ossa innominata, the os sacrum, and os coccygis, form the bony sides of the cavity of the abdomen.

The *diaphragm*, the *musculi abdominis*, the *quadrati lumborum psoai, iliaci*, the *muscles of the coccyx*, and of the *intestinum rectum*, form the chief part of the surface of this cavity; and its whole inner surface is lined by a membranous expansion, termed *peritonaeum*, all these parts being covered by the integuments already mentioned. As additional or auxiliary parts, we might likewise add some portions of the sacro lumbares, longissimi dorsi, vertebrales, glutaei, &c.

The cavity of the abdomen is of an irregularly oval figure, but still symmetrical. On the foreside it is uniformly arched or oval, and its greatest capacity is even with the navel and neareſt part of the hypogastrium. On the upper side it is bounded by a portion of a vault, very much inclined. On the back-side it is in a manner divided into two cavities by the jetting out of the vertebrae of the loins. On the lower side it contracts gradually all the way to what I call the *little edge* of the pelvis; and from thence expands again a little as far as the os coccygis, and tubercles of the ischium, terminating in the void space between these three parts.

§ 1.

§ 1. *Peritonaeum.*

HAVING carefully removed the muſcles of the abdomen, the firſt thing we diſcover is a very conſiderable membranous covering, which adheres immediately to the inner ſurface of the muſculi tranſverſi, and of all the other parts of this cavity, and involves and inveſts all the viſcera, as in a kind of bag. This membrane is named *peritonaeum*, from a Greek word, which ſignifies to be ſpread around.

The peritonaeum, in general, is a membrane of a cloſe texture, and yet very limber, and capable of a very great extenſion; after which it can recover itſelf, and be contracted to its ordinary ſize, as we ſee in pregnancy, dropſies, corpulency, and repletion.

It may be looked upon as a ſingle membrane, although it has been deſcribed by many anatomiſts as a duplicature of two diſtinct membranous laminae. But, properly ſpeaking, the internal portion alone deſerves the name of a *membranous lamina*, as being the main body of the peritonaeum. The external portion may properly enough be termed the *cellular ſubſtance of the peritonaeum.*

The inner ſubſtance of the peritonaeum is very ſmooth and poliſhed on that ſide which is turned to the cavity and viſcera of the abdomen, and continually moiſtened by a ſerous fluid diſcharged through almoſt imperceptible pores.

Theſe pores may be ſeen by ſpreading a portion of the peritonaeum on the end of the finger, and then pulling it very tight on all ſides; for then the pores are dilated, and ſmall drops may be obſerved to run from them, even without a microſcope.

The ſources of this fluid are chiefly from the exhalent veſſels. The whitiſh corpuſcles found in diſeaſed ſubjects are

no

no proof of the glands, which ſome anatomiſts place there in the natural ſtate.

The cellular ſubſtance or external portion of the peritonæum, adheres very cloſely to the parts which form the inſides of the cavity of the abdomen; and it is not every where of an equal thickneſs. In ſome places it is in a very ſmall quantity, and ſcarcely any appears at the tendinous or aponeurotic portions of the muſculi tranſverſi, and on the lower ſide of the diaphragm.

In all other places it is thicker, and forms cells expanded into very fine laminæ, which, in diſeaſed ſubjects, becomes ſometimes ſo broad and thick, as to reſemble ſo many diſtinct membranes.

In ſome places, this ſubſtance is every way like a membrana adipoſa, being filled with fat, as round the kidneys, and along the fleſhy portions of the tranſverſe muſcles, to which it adheres. It entirely ſurrounds ſome parts, as the bladder, ureters, kidneys, ſpermatic veſſels, &c. and it is in theſe places improperly termed the *duplicature of the peritonæum.*

Beſides theſe differences in thickneſs, the cellular ſubſtance has ſeveral elongations, which have been called *productions of the peritonæum.* Two of theſe productions accompany and inveſt the ſpermatic ropes in males, and the vaſcular ropes, commonly called the *round ligaments*, in women. Two other paſs under the ligamentum Follopii, with the crural veſſels, which they involve; and they are gradually loſt in their courſe downward.

To theſe four productions of the cellular ſubſtance of the peritonæum, we may add a fifth, which is ſpread on the neck of the bladder: and perhaps a ſixth, which accompanies the inteſtinum rectum. All theſe elongations paſs out of the cavity of the abdomen, and may be termed *external*, to diſtinguiſh them from others that remain in the abdomen, and are called *internal*; of which hereafter.

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The great blood veſſels, that is, the aorta and vena cava, are likewiſe involved in this cellular ſubſtance of the peritonaeum. In a word, it involves immediately and ſeparately, all the parts and organs which are commonly ſaid to lie in the duplicature of the peritonaeum.

The true lamina, or membranous portion of the peritonaeum, is connected by the intervention of the cellular ſubſtance to the inner ſurface of the cavity of the abdomen; but it does not naturally accompany the external elongations of that ſubſtance. It only covers the origin or baſis of theſe productions, without any alteration in its own ſurface at theſe places.

It has, nevertheleſs, productions of its own; but they are very different from thoſe of the cellular ſubſtance; for they run from without inward, that is, they advance from the convex ſide of the great bag of the peritonaeum into the cavity of that bag, ſome more, ſome leſs, and alſo in different manners, as if the ſides of a large ball or bladder were thruſt inward into the cavity of the ball or bladder.

Of theſe internal elongations of the peritonaeum, ſome are ſimply folded like a duplicature; others are expanded like inverted bags, or facculi, to contain ſome viſcus; others begin by a ſimple duplicature, and are afterwards expanded into a cavity which contains ſome organ; others are alternately extended in the form of ſimple duplicatures and of cavities; and, laſtly, others form only a ſmall eminence on the inner ſurface of the great cavity of the peritonaeum.

Under the firſt ſpecies of theſe productions, we may bring the membranous ligaments of the abdomen, ſuch as thoſe of the liver, colon, &c. We ſee the ſecond ſpecies in the external membrane of the liver; the third in the meſentry; the fourth in the meſocolon; and the fifth at the kidneys and ureters.

Beſides the external productions of the cellular ſubſtance of the peritonaeum, it has the ſame number of internal elongations with the true lamina, which lie between all the duplicatures, and line the inſides of all the cavities, or that ſide next the viſcera contained in them.

The veſſels and nerves of the peritonaeum are from thoſe that ſupply the neighbouring parts. The arteries come from the mammariae internae, the intercoſtales inferiores, the lumbares, the arteriae ſacrae, the ilio lumbares, the epigaſtricae, the ſmall anterior iliacs, the inferior diaphragmatics, and from the veſſels which ſupply the abdominal viſcera. The veins correſponding with theſe arteries have the ſame courſe and bear the ſame names. The nerves of this membrane are few in number, and ſmall; They come from the great intercoſtals, from the lumbars and ſacrals.

The uſes of the peritonæum, in general, ſeem to be very evident from the deſcription which has been given of it: The chief of theſe uſes are, to line the cavity of the abdomen, to inveſt the viſcera contained in that cavity as in a common bag, to ſupply them with particular coats, and to form productions, ligaments, connections, folds, vaginae, &c. as we ſhall ſee hereafter.

The fine fluid which tranſudes through the whole internal ſurface of the peritonaeum prevents the inconveniencies which might ariſe from the continual frictions and motions to which the viſcera of the abdomen are expoſed, either naturally or by external impulſes.

We muſt here obſerve, that it is the common cuſtom to demonſtrate four ligamentary ropes, termed the *umbilical veſſels*, before the peritonaeum is opened, becauſe they adhere to the umbilicus; three of them are really veſſels in the foetus, viz. two umbilical arteries and one vein. We are in a manner obliged to ſubmit to this cuſtom in public anatomical demonſtrations, where we have but one ſubject for the whole;

whole; but as we are here under no ſuch neceſſity, we refer the deſcription of theſe ligaments to other more proper places of this work. The venal ligament ſhall be deſcribed in the hiſtory of the liver; and the two arterial ligaments, together with the urachus, which is the fourth, in the hiſtory of the bladder.

It is ſufficient to obſerve here in general, that three of theſe umbilical ropes or ligaments are involved ſeparately, and ſuſtained by a production or duplicature, which the peritonæum ſends into the cavity of the abdomen in form of a falx.

§ 2. *Ventriculus.*

Situation and figure of the ſtomach. The ſtomach is a great bag or reſervoir, ſituated partly in the left hypochondrium, and partly in the epigaſtrium.

The figure of the ſtomach is like that of a bag of a bagpipe; that is, it is oblong, incurvated, large, and capacious, at one end, and ſmall and contracted at the other. We ſee this figure moſt evidently when the ſtomach is moderately filled with air, or with any other fluid.

The curvature of the ſtomach gives us occaſion to diſtinguiſh two arches in it; one large, which runs along the greateſt convexity; and one ſmall, directly oppoſite to the former. Theſe arches are named the *great* and *ſmall* curvatures of the ſtomach; and by the ſides of the ſtomach, we underſtand the two lateral portions which lie between the two arches.

The ſtomach has two extremities, one large and one ſmall. It has two openings, called the *orifices of the ſtomach*; one between the great extremity and the ſmall curvature, the other at the end of the ſmall or contracted extremity. The firſt opening

opening is a continuation of the oeſophagus; the other joins the inteſtinal canal, and is called by the name of *pylorus*.

The ſtomach is not ſituated in the left hypochondrium and epigaſtric region, in the manner repreſented in moſt of the figures. It lies tranſverſely, obliquely, and almoſt laterally; in ſuch a manner as that the great extremity, and the orifice next it, are on the left ſide; and the ſmall extremity, with its orifice, or the pylorus, on the right ſide, and lower and more inclined than the former. Therefore we ought, with the antient anatomiſts, to call one of theſe orifices *ſuperior*, the other *inferior*.

The great extremity of the ſtomach is in the left hypochondrium, and for the moſt part immediately under the diaphragm; Yet the ſuperior orifice is not in the left hypochondrium, but almoſt oppoſite to, and very near the middle of, the bodies of the loweſt vertebrae of the back.

The ſmall extremity of the ſtomach does not reach to the right hypochondrium. It bends obliquely backwards toward the upper orifice; ſo that the pylorus lies about two fingers breadth from the body of the vertebrae immediately under the ſmall portion of the liver; and conſequently lower down, and more forward, than the other orifice by almoſt the ſame diſtance. This extremity of the ſtomach has ſometimes a particular dilatation on the ſide next the great curvature.

According to this natural ſituation, the ſtomach, eſpecially when full, is ſituated with its great curvature forward, and a little downward, and its ſmall curvature backward and a little upward.

One of the lateral convex ſides is turned upward, the other downward; and not forward and backward, as they appear in dead bodies, where the inteſtines do not ſupport them in their natural ſituation.

If we divide the ſtomach along the two curvatures into two equal parts, we ſhall ſee that the two orifices do not both adhere

adhere to the ſame half of this diviſion, as we would be apt to imagine according to the common notion; but that the diaphragmatic orifice is entirely in the upper half, and the inteſtinal orifice in the lower.

Therefore the body of the ſtomach is ſo far from lying in the ſame plane with the oeſophagus, as it is commonly repreſented in figures drawn from a ſtomach taken out of the body, and laid upon a table, that it forms an angle or fold immediately at the paſſage of the oeſophagus, through the ſmall muſcle of the diaphragm; and it is on account of this angle that the ſuperior orifice is turned backward.

Structure of the ſtomach. The ſtomach is compoſed of ſeveral parts; the chief of which are the different ſtrata which form its ſubſtance, to which anatomiſts give the name of *tunicae* or *coats*. Theſe coats are commonly reckoned to be four in number; the outer or common, the fleſhy or muſcular, the nervous or aponeurotic, and the villous or inner coat; and they are afterwards ſubdivided ſeveral ways.

The firſt or outermoſt coat is ſimply membranous, being one of the internal productions of the peritonaeum. This appears evidently at the connection of the ſuperior orifice with the diaphragm, where the external membrane of the ſtomach is really continuous with the membrane which lines the inferior ſurface of the diaphragm; and it is from this that it has been named the *common coat*.

The ſecond or muſcular coat is made up of ſeveral planes of fibres, which may all be reduced to two; one external, the other internal. The external coat is longitudinal, though, in different reſpects, following nearly the direction of the curvatures and convexities of the ſtomach; and the internal plane is tranſverſely cellular.

The fibres of the external plane run ſlanting in ſeveral places; and are interſected by ſmall oblique whitiſh lines, which ſeem to be in ſome meaſure tendinous. This plane is ſtrengthened

ſtrengthened by a particular faſciculus which runs along the ſmall curvature, its fibres appearing to be leſs oblique than thoſe of the great plane.

The fibres of the inner or circular plane of this muſcular coat are ſtronger than thoſe of the outer plane. They are rather ſegments which unite at different diſtances, than entire circles; and they are likewiſe interſected by great numbers of ſmall white lines, in ſome meaſure tendinous, and very oblique, which altogether repreſent a kind of net-work, the areolae or meſhes of which are very narrow.

As theſe circles or ſegments advance on the great extremity of the ſtomach, they diminiſh gradually, and form a kind of muſcular vortex; the centre of which is in the middle of that extremity.

Between the outer and inner planes, round the ſuperior orifice, there are two diſtinct planes about the breadth of a finger, and very oblique, which ſurround this orifice in oppoſite directions, and interſect each other where they meet on the two lateral ſides.

Along the middle of each lateral ſide of the ſmall extremity, there runs a tendinous or ligamentary flat portion, above a quarter of an inch in breadth, which terminates in the pylorus. Theſe two portions lie between the common and muſcular coats, and adhere very ſtrongly to the firſt.

Between the two ſame coats, there is a cellular ſubſtance which adheres very cloſely to the external coat, and inſinuates itſelf between the fleſhy fibres of the ſecond, all the way to the third, as may be perceived by blowing it up. Some make it a diſtinct coat, and call it *tunica celluloſa*; but it is no more than the cellular portion of the membranous coat, like the cellular portion of the peritonaeum.

The third coat, commonly called *tunica nervoſa*, but properly *tunica celluloſa*, is compoſed of capillary veſſels and nerves, with a very large proportion of cellular ſubſtance.

On

On the convave ſide, it ſeems to be of a very looſe ſpongy or filamentary texture, reſembling fine cotton, as may be ſeen by macerating it a little in clear water, which ſwells it conſiderably in a very ſhort ſpace of time. It is ſupported by a kind of ground-work of a very fine ligamentary or aponeurotic filaments which interſect each other obliquely, much in the ſame manner as the third coat of the inteſtines; of which hereafter; and it adheres to the convex ſide of the villous coat.

The fourth coat of the ſtomach has been termed by Fallopius *tunica villoſa*, becauſe, when it ſwims in clear water, ſomething is ſeen in it like the pile of velvet. The ancients called it *tunica fungoſa*; and perhaps this name agrees beſt with its true ſtructure.

Theſe two coats are of a larger extent than the two former, and they join in forming large rugae on the concave ſurface of the ſtomach; the greateſt part of which is tranſverſe, though irregular and waving. There are likewiſe ſome longitudinal ones which interſect the others; but at the pylorus they all become longitudinal, and terminate there.

At the ſuperior orifice of the ſtomach, theſe rugae are in a manner radiated, and ſeem to be a continuation of the plicae or folds of the oeſophagus; only they are thicker; and where theſe rugae and plicae meet, they form a ſort of crown, which diſtinguiſhes the ſuperior orifice of the ſtomach from the inferior extremity of the oeſophagus.

In the interſtices of theſe rugae there is often found a ſort of ſlimy mucus, with which the whole cavity of the ſtomach ſeems likewiſe to be moiſtened. This mucus, which is termed *ſuccus gaſtricus* or *ſtomachicus*, is much more fluid in living than in dead bodies, and has been ſuppoſed by Winſlow, Leber, &c. to be ſupplied by ſmall glands ſituated in the ſubſtance of the ſtomach. But Morgagni and Haller have ſeldom ſeen ſuch an appearance; and Sabatier obſerves, that, when

when ſuch an appearance is met with, it may be conſidered as the effect of diſeaſe, and that nothing is more doubtful than the exiſtence of glands in this place.

On the inner ſurface of the ſmall extremity of the ſtomach, at the place where it ends in the inteſtinal canal, we obſerve a broad, thin, circular border, with a roundiſh hole in the middle. This hole is the inferior orifice of the ſtomach, called by the Greeks *pylorus*, which ſignifies a porter.

This border is a fold or duplicature of the two inner coats of the ſtomach, the nervoſa and villoſa; and it is formed in part by a faſciculus of fleſhy fibres mixed in the duplicature of the tunica nervoſa, and diſtinguiſhed not only from the other fleſhy fibres of the extremity of the ſtomach, but alſo from thoſe of the inteſtines, by a thin, whitiſh circle, which appears even through the external or common coat, round the union of the ſtomach and inteſtines.

The figure of the pylorus is that of a ring tranſverſely flatted; the inner edge of which, or that next the centre, is turned obliquely toward the inteſtines. This inner edge runs naturally more or leſs into little plaits or gathers, like the mouth of a purſe almoſt ſhut; all which particulars are very different from what figures and dried preparations would make us believe. It is therefore a kind of ſphincter, which can contract the inferior orifice of the ſtomach, but ſeems not capable of ſhutting it quite cloſe.

Arteries of the ſtomach. The principal arteries of the ſtomach are the coronaria ſiniſtra, which goes firſt to the cardia, and from this runs along the ſmall curvature; coronaria dextra, which runs from the arteria hepatica to the right end of the ſmall curvature, and joins the coronaria ſiniſtra; gaſtro-epiploica dextra, which ariſes from the arteria hepatica, and runs along the great curvature; arteria gaſtro-epiploica ſiniſtra and vaſa brevia, which ariſe from the arteria ſplenica, and run along the left end of the great curvature.

Theſe

Theſe two arterial arches ſend a great number of branches towards each other on both ſides of the ſtomach; and theſe branches are gradually ramified in different directions, by very different diviſions and ſub-diviſions; the greateſt part of which communicate with thoſe from the other artery.

From theſe frequent ramifications and communications of the arterial arches of the ſtomach, two different reticular textures ariſe; one, which is the largeſt, lies between the common and muſcular coats in the cellular ſubſtances found there; the other, which is very fine, lies on the ſurface of the tunica nervoſa. This latter is a production of the firſt, being formed by means of a great number of very ſhort rami, which go out from the other, and paſs through the ſmall interſtices between the fibres of the muſcular coat.

By artifical injections we can ſhew a third extremely fine reticular texture of capillary veſſels, which run between the glandular bodies and papillae of the tunica villoſa. Theſe do not ſeem, in their natural ſtate, to be purely blood veſſels, as inflammations and injections may incline us to think.

The arteries of the ſtomach come originally from the caeliaca, by means of the hepatica, ſplenica, and coronaria. The pylorica and meſenterica ſuperior likewiſe contribute to them by communications, more or leſs immediate. They communicate alſo with the mammariae internae, and diaphragmaticae, and, by means of the epigaſtrica ſiniſtra, with the meſenterica inferior.

Veins of the ſtomach. The veins of the ſtomach are ramifications of the vena portae in general; and in particular of the meſeraica major, ſplenica, and meſenterica inferior; the diſtribution of which may be ſeen in the deſcription of the veins. They accompany the arteries more or leſs, and form nearly the ſame kinds of arches and reticular textures; with this difference, that they are proportionally greater, their reticular

ticular areolae larger, and their external communications more frequent.

Nerves of the ſtomach. Between the common and muſcular coats of the ſtomach, we find a great number of nerves of different ſizes. Many of them accompany each other, in form of a broad flat faſciculus, along the ſmall curvature of the ſtomach from the ſuperior to the inferior orifice. The reſt are ſpread in different directions, on the ſides, extremities, and great curvature, forming at different diſtances a kind of reticular plexus, from which a great number of filaments are detached to the inner coats.

They ariſe chiefly from the nervi ſympathetici medii, or eighth pair, by means of the plexus coronarius ſtomachicus formed round the ſuperior orifice of the ſtomach, by the expanſion of the extremities of two large ropes, which run down upon the oeſophagus, by the name of *nervi ſtomachici.* The great ſympathetic nerve, commonly called *intercoſtalis,* contributes likewiſe to them, by communicating filaments, which the plexus ſtomachicus receives from the ſemilunar ganglions of the plexus hepaticus, and particularly from the plexus ſplenicus. See Walter's beautiful and accurate Tables of the Nerves of the Thorax and Abdomen.

Uſes of the ſtomach. The ſtomach receives in general whatever the mouth and tongue ſend thither through the canal of the oeſophagus: But its particular uſe is to receive the aliments; to contain them for a longer or ſhorter time, in proportion as they are more ſolid or fluid; and to digeſt them, that is, to put them in a condition to be turned into that nutritious fluid called *chyle.*

This operation, which goes by the general name of *digeſtion,* and by which chylification begins, is performed partly by the ſuccus gaſtricus, which flows continually from the tunica villoſa, and partly by the continual contraction and relaxation of the muſcular coat. Theſe motions in men are

but

but very weak, and nowiſe ſufficient for digeſtion, without the aſſiſtance of the alternate motions of the diaphragm and muſcles of the abdomen.

The pylorus, or fleſhy circle of the inferior oriſice of the ſtomach, ſerves to retain the aliments in it till they have acquired a ſufficient degree of fluidity to paſs eaſily through that opening. But by a particular irritation of the muſcular coat of the ſtomach, and ſtill more by a violent contraction of the diaphragm and muſcles of the abdomen, the contents of the ſtomach may be very ſoon forced towards the ſmall extremity, and puſhed through the pylorus.

The gentle and alternate motions of the orbicular fibres of the muſcular coat may aſſiſt in ſending through the pylorus, in the natural way, the aliment that is ſufficiently digeſted. This was called the *periſtaltic* or *vermicular motion*, by thoſe who believed that it is ſucceſſively reiterated, like that of earth-worms when they creep.

Trituration might be a proper enough term for this operation, provided it be made to ſignify only a gentle agitation or action of the fleſhy fibres in a ſubſtance continually moiſtened by the gaſtric liquor, and not a violent grinding of a dry ſubſtance.

The ſituation of the ſtomach, which is nearly tranſverſe, is likewiſe of uſe in making the aliment remain long enough in that cavity; and may ſerve to make the length of this ſtay, in ſome meaſure, arbitrary, by means of the different poſtures of the body; for, when we lie on the left ſide, the aliment muſt remain longer than when we lie on the right, &c.

The obliquity of the ſtomach may ſerve to clear up a difficulty that very much torments thoſe who believe that both orifices of the ſtomach lie on the ſame level; which is, how any heavy ſubſtance, once got into the ſtomach, can ever riſe again to this level, to paſs into the inteſtines.

§ 3.

§ 3. *The inteſtines in general.*

Situation, ſize, and diviſion of the inteſtines. Between the pylorus and the very loweſt part of the abdomen lies a long canal, bent in a great many different directions by numerous convolutions or turnings, called the *inteſtines*.

This canal, thus folded and turned, forms a conſiderable bulk, which fills the greateſt part of the cavity of the abdomen; and it is connected through the whole extent to membranous productions or continuations of the peritonaeum, principally to thoſe called the *meſentery* and *meſocolon*; of which hereafter.

The incurvations of the inteſtinal canal form two arches; a ſmall one, by which it is connected to the meſentery and meſocolon; and a great one on the oppoſite ſide, which lies looſe. The whole canal is generally about ſix or ſeven times as long as the ſubject.

The inteſtinal canal is neither of an equal ſize nor thickneſs through its whole length; from whence anatomiſts have taken occaſion to conſider its different portions as ſo many particular inteſtines, and to divide them all into ſmall and great.

And as they ſtill found ſome differences in each claſs taken altogether, they divided each into three portions, which they diſtinguiſhed by particular names. In the ſmall inteſtines, the three portions are named *duodenum*, *jejunum*, and *ileum*; and in the great inteſtines, *caecum*, *colon*, and *rectum*.

Structure of the inteſtines. The inteſtines in general are compoſed of ſeveral coats, much in the ſame manner with the ſtomach. The firſt and outermoſt is a continuation of the meſentery, or of ſome other elongation or duplicature of the peritonaeum.

This

This is commonly termed the *common coat*; and it has a cellular ſubſtance on its inner ſurface, like that of the ſtomach, which M. Ruyſch thought fit to call a diſtinct coat by the name of *tunica celluloſa*.

The ſecond coat of the inteſtines is fleſhy or muſcular, and made up of two planes; one external, the other internal. The external plane is very thin, and its fibres longitudinal; the internal plane is thicker, and its fibres run tranſverſely round the circumference of the inteſtinal cylinder.

It would appear that theſe fibres are neither ſpiral, nor are they formed of perfect circles or of rings; but they ſeem rather to be ſegments of circles, diſpoſed much in the ſame manner as in the ſtomach, and thus ſurrounding entirely the inteſtinal canal.

Theſe two planes adhere cloſely together, and are ſeparated with great difficulty. They adhere likewiſe to the common coat by the intervention of the cellular ſubſtance, which is in greater quantities on the ſide next the meſentery than on the other.

The third coat is called *nervoſa*, and is ſomething like that of the ſtomach. It has a particular plane, which ſerves as a baſis to ſuſtain it, made up of very fine ſtrong, oblique fibres, which ſeem to be of the ligamentary or tendinous kind.

To ſee this plane diſtinctly, a portion of the inteſtines muſt be inflated, the common coat removed, and the fleſhy fibres ſcraped off.

This coat ſuſtains two reticular ſubſtances, which are both vaſcular, one arterial, the other venal, accompanied by a great number of nervous filaments. Theſe veſſels and nerves are productions of the meſenteric veſſels and nerves; and, as they ſurround the whole canal of the inteſtines, ſome anatomiſts have formed them into a diſtinct coat, by the name of *tunica vaſculoſa*.

The

The nervous coat ſends off from its inner ſurface a great number of portions or ſepta, more or leſs circular, which contribute to the formation of what are called *valvulae conniventes*; of which hereafter. It likewiſe ſeems to ſuſtain ſeveral different glandular bodies, which we diſcover in the cavity of the inteſtines.

The fourth or innermoſt coat is very ſoft, and is named *tunica villoſa*. It has the ſame extent with the third coat, which ſupports it; and it lines all the ſepta of that third coat; but it is not uniform through the whole canal, as we ſhall ſhew in the particular deſcription.

It is now generally believed that the fourth coat is a continuation of that in the ſtomach, and, of conſequence, from the epidermis.

Inteſtina tenuia. The ſmall inteſtines form one continued uniform canal; and, although three portions of it have three different names, yet we have no ſufficient marks whereby to diſtinguiſh them, to fix the preciſe extent or length of each portion, or to ſettle its juſt limits.

The firſt and ſmalleſt portion of the whole canal is called *duodenum*; the ſecond, which is much longer, *jejunum*; and the third, which is ſtill longer than the ſecond, *ileum*.

§ 4. *Inteſtinum Duodenum.*

THE firſt portion of the ſmall inteſtines was called *duodenum*, from the length aſcribed to it by the antients, viz. the breadth of twelve fingers; and the moderns need not cavil much about this length, if it is meaſured with the ends of the fingers of the ſubject.

This inteſtine having ariſen from the pylorus, is immediately bent a little backward and obliquely downward; then it bends a ſecond time toward the right kidney, to which it is a little connected; and from thence paſſes before the renal artery

artery and vein, afcending inſenſibly from right to left, till it gets before the aorta, and laſt vertebrae of the back. It continues its courſe obliquely forward by a gentle turn, which may be reckoned a third incurvation, and alſo the extremity of the duodenum.

Through this whole courſe the duodenum is firmly bound down by the folds of the peritonaeum, eſpecially by a tranſverſe duplicature which gives origin to the meſocolon. The two lamina of this duplicature being at firſt ſeparate, and ſoon afterward uniting, muſt leave a triangular ſpace between them, which is lined with a cellular ſubſtance.

It is in this ſpace that the duodenum adheres, by means of the cellular ſubſtance, to the parts already named; and the inteſtine is contained therein, as in a caſe; ſo that, without diſſection, we can ſee nothing but its two extremities; and even theſe are hid by the colon, and by the firſt convolutions of the jejunum.

Structure of the duodenum. The firſt coat of the duodenum is conſequently different from that of the other ſmall inteſtines, having this peculiar to it, that it does not inveſt the whole circumference of the inteſtine; becauſe, through the greateſt part of the length, it lies in the triangular ſpace already mentioned; and, for the ſame reaſon, there is a greater quantity of cellular ſubſtance belongs to the outer coat of the duodenum than to that of the other inteſtines.

The muſcular coat of the duodenum is thicker than in the jejunum and ileum.

The tunica nervoſa and villoſa form conjointly, on the inſides of this inteſtine, a great number of ſmall duplicatures, which advance into the cavity more or leſs directly, like portions of circular planes, with one edge fixed to the inteſtine, and the other looſe. Theſe are what anatomiſts call *valvulae conniventes*.

The

The looſe or floating edge of theſe valves is formed into ſmall gathers or waves in the natural ſtate. The whole ſurface of theſe duplicatures or valves is villous, as well as that of the inteſtines between them.

The villi of this inteſtine are thicker than in the ſtomach; but the texture of them in man is not like hairs, as they are commonly repreſented in figures, but rather like that of a fungous granulated ſubſtance, compoſed of an infinite number of very fine papillae of different figures; in which we ſee, through a microſcope, a multitude of depreſſed points or pores by which their whole ſurface ſeems to be pierced.

By the ſame help we obſerve, on different places of the inner ſurface of this inteſtine, ſeveral round villous tubercles, riſing like ſmall verrucae at different diſtances from each other.

This ſubſtance ſuſtains an infinite number of capillary veſſels of different kinds; for, beſides the blood-veſſels, we ſometimes obſerve a great number of white filaments which run through it, and end at its inner ſurface like ſo many capillary roots of the veſſels called *venae lacteae*. When the villous ſubſtance is examined in the microſcope, beſides the blood-veſſels, numerous follicles are obſerved lodged in cellular ſubſtance. Theſe have been conſidered as the origin of the lacteal veſſels, and have been called *ampullulae of Leiberkuhn*, becauſe he firſt diſcovered them.

The fungous ſubſtance which bind theſe capillary filaments together, and ſurrounds them, is very tender; and the capillary extremities of the ſmall blood-veſſels, diſtributed through it, ſeem to be turned toward the pores of the papillae. Through theſe pores a mucous fluid, more or leſs tranſparent, is diſcharged, which continually moiſtens the cavity of the inteſtine.

Glands of the duodenum. The internal ſurface of the duodenum is furniſhed with a great number of ſmall flat glandular

dular tubercles, named after Brunner, which are raiſed on the ſides, and depreſſed in the middle by a kind of foſſula; and they are more numerous near the beginning of this inteſtine than any where elſe. About the pylorus they lie as it were in heaps or cluſters; and from thence the diſtance between them increaſes gradually all the way to the other extremity where they are ſingle.

Theſe glands, when examined carefully, appear like little bladders, with the orifices turned towards the cavity of the inteſtine, and the bodies fixed in the ſpongy ſubſtance next the nervous coat. They furniſh a particular fluid, which is often found to be viſcid.

The biliary orifice of the duodenum. In the inner ſurface of the duodenum, almoſt at the lower part of the firſt incurvation, and on the ſhorteſt ſide, there is a longitudinal eminence, in the point or apex of which lies a particular opening, which is the orifice of the ductus biliarius, within which the ductus pancreaticus likewiſe opens.

This inteſtine is commonly the wideſt, though the ſhorteſt, of the inteſtina tenuia, and has been called by ſome authors *ventriculus ſuccenturiatus*; and is inveſted with more cellular ſubſtance, eſpecially while within its triangular caſe, where it wants the outer coat which the others have; and conſequently it is more eaſily dilatable by the ſubſtances which might otherwiſe ſtick within it.

§ 5. *Inteſtinum Jejunum.*

Situation and ſize of the jejunum. The jejunum, ſo called becauſe it is oftener found empty than the ileum, begins at the laſt incurvation of the duodenum, and is there connected to the beginning of the meſocolon.

From thence it bends downward from left to right, and obliquely forward, or from the vertebrae, and makes ſeveral

convolutions, which lie chiefly in the upper part of the umbilical region. Through all this courſe it is connected to the meſentery, in the manner that ſhall be explained hereafter.

It is a difficult matter to fix the exact bounds between this inteſtine and the ileum. The external marks of a redder colour in the one than the other, though generally common, are not conſtant; and the internal marks fixed from the plurality of valvulae conniventes are indeterminate, and oftentimes appear only from diſſection.

Theſe two inteſtines may be better diſtinguiſhed by their different ſituations, which are very regular; but, as even this mark is not particular enough, the moſt eaſy way that I have been able to contrive, and which will, in moſt caſes, be found ſufficiently exact, is to divide both inteſtines into five parts, and to allow nearly two-fifths to the jejunum and three fifths and a little more to the ileum.

Structure of the jejunum. The coats of the jejunum are nearly of the ſame ſtructure with thoſe of the duodenum, but thinner. The common coat is a continuation of the meſentery; and the cellular ſubſtance is in leſs quantity than in the duodenum, and indeed ſeems to be altogether wanting along the great curvature of the convolutions, where the longitudinal fibres of the muſcular coat adhere very cloſely to the external membrane.

This muſcular coat is not ſo ſtrong as that of the duodenum. The longitudinal plane of fibres is very thin, and almoſt imperceptible, except along the great curvature, oppoſite to the connection of the meſentery, where we ſee, through the membranous coat, a kind of whitiſh ligamentary band, about the third part of an inch in breadth, which is continued along the great curvature of all the convolutions of this inteſtine, and of the ileum.

This ligamentary band is like thoſe which we obſerve on the ſides of the ſmall extremity of the ſtomach. It adheres perfectly

perfectly to the membranous coat, and to the longitudinal fibres of the muſcular, which are here more viſible, and appear to be ſtronger than in any other place.

The tunica nervoſa, which we chooſe rather to call *reticularis*, and its proper cellular or lanuginous ſubſtance, have nothing peculiar to them more than has been already ſaid about the inteſtines in general. By blowing artfully into this ſubſtance, it may be made to ſwell ſo much, round the whole cavity of the inteſtines, as to deſtroy all the duplicatures or valvulae conniventes.

Theſe valves in this inteſtine are very broad, very numerous, and very near each other. On the ſide of the great curvature, their circumference is continuous and uniform; but next the ſmall curvature, there are ſeveral breaks in them, the extremities of ſome advancing beyond the reſt, and terminating in points. Some of theſe valves go quite round, others only ſome part of the way; and ſome of them are very ſmall, which go obliquely between two large ones, forming a kind of communication.

The papillae of the tunica villoſa are here more raiſed, looſe, and floating than in the duodenum; and each of them ſeems to be divided into ſeveral others, by inciſures of a very ſingular kind. In other reſpects they nearly agree with what was ſaid in the deſcription of the inteſtines in general. The obſervations and figures publiſhed by M. Helvetius, firſt phyſician to the French Queen, in the Memoirs of the Royal Academy, expreſs theſe papillae, and the whole tunica reticularis, very juſtly.

The glandular lacunae of the jejunum are of the ſame ſtructure with the glandulae Brunneri or duodenales; but they are diſpoſed in a different manner. They are partly ſingle, at different diſtances from each other; and partly in ſeveral cluſters, like flat oblong branches of grapes, called *plexus glanduloſi Peyeri*. Theſe are in the largeſt quantity near

near the great curvature, and they croſs thro gh ſeveral valvulae conniventes at once.

The veſſels, nerves, connections, &c. muſt be referred till the meſentery has been deſcribed.

§ 6. *Inteſtinum Ileum.*

Situation of the ileum. The convulutions of this inteſtine ſurround thoſe of the jejunum on the two lateral and lower ſides, and it paſſes in a winding courſe from the left ſide, by the hypogaſtrium, to the right ſide, where it terminates a little below the right kidney, joining the inteſtina craſſa, in the manner that we ſhall relate hereafter. The lateral convolutions are ſupported by the offa ilium, ſo called, not from this inteſtine, but from the region of the abdomen termed *ilia*.

Structure of the ileum. The ſtructure of the ileum is much the ſame with that of the jejunum; only the internal duplicatures, or valvulae conniventes, decreaſe gradually both in number and ſize. Near the extremity of the ileum their direction is changed; and, inſtead of being tranſverſe or circular, they become longitudinal, and terminate in a kind of pylorus, which advances into the cavity of the great inteſtines, as we ſhall ſee preſently.

We obſerve likewiſe in this inteſtine, as in the jejunum, ſingle or ſolitary glands or lacunae, and alſo reticular glands, or glands in cluſters; the laſt of which, at the extremity of this inteſtine, are often of a large extent. But the greateſt part of theſe glands appear to be flatter here than in the jejunum. The cellular ſubſtance of the external coat is in leſs quantities than in the foregoing inteſtines; and the ileum appears commonly more pale, or not ſo red as the jejunum.

Sometimes, though rarely, we meet with proceſſes ſent off from the jejunum or ileum, and of the ſame ſtructure with theſe inteſtines. Their form, being ſimilar to that of the finger

of

of a glove, appears to have given them the name of *appendices digitales*. They are mentioned by different anatomiſts, and have ſometimes been found to form true herniae.

The veſſels, nerves, connections, &c. muſt be referred to the hiſtory of the meſentery.

§ 7. *The Inteſtina Craſſa in general.*

The great inteſtines are one continued canal, divided into three portions, like the ſmall ones. This canal begins by a kind of ſacculus or bag, which is reckoned the firſt of the three portions, and called *caecum*. The ſecond portion, called *colon*, is the longeſt of the three, and is diſtinguiſhed from them by a great number of particular eminences or convexities, which appear on its outer ſurface through its whole length. The laſt portion is named *rectum*; being more uniform, narrower, thicker, and much ſhorter, than the colon.

The ſtructure of the great inteſtines is nearly the ſame with that of the ſmall ones, in regard both to the number and diſpoſition of their coats. They are ſhorter, and have fewer convolutions, but are much more capacious. The coats in general are ſtronger, but eſpecially the muſcular coat. The villi and mucilaginous glands are different; and there are ſeveral other things relating to them which will come in better in the particular hiſtory.

Situation and ſtructure of the caecum. The inteſtinum caecum is only a round ſhort broad bag, the bottom of which is turned downward, and the mouth or opening upward. It lies under the right kidney, and is hid by the laſt convolution of the ileum. It has nothing to diſtinguiſh it from the colon, excepting that it is a little wider, is ſhut at its under end, and gives origin to the appendicula vermiformis.

Appendicula vermiformis. On one ſide of the bottom of the caecum lies an appendix, reſembling a ſmall inteſtine, nearly

of

of the ſame length with the caecum, but very ſlender. It is termed *appendicula vermiformis*, from its ſuppoſed reſemblance to an earth-worm. Its common diameter is not above a quarter of an inch. By one extremity it opens laterally and a little obliquely into the bottom of the caecum; and the other extremity is cloſed, being ſometimes greater, ſometimes ſmaller, than the reſt of the appendix.

It has ſome contortions, like thoſe of a worm when it is touched, from whence comes the epithet of *vermicularis* or *vermiformis*. Its ſtructure reſembles nearly that of the other inteſtines.

The internal coat of this appendix is folliculous, like that of the duodenum; and it is likewiſe reticular, the meſhes being the glandular lacunae, which continually diſcharge a fluid into its cavity.

It has often been diſputed whether this appendix, or the large portion, which is, as it were, the head of the colon, ought to be called the *caecum*: but the general diviſion of the inteſtines into great and ſmall, leaves no room to doubt of its being only an appendix in man, whatever reaſon there may be for talking differently with reſpect to brutes and birds.

Through the membranous or common coat of the caecum, we ſee three white muſcular ligamentous looking bands, which adhere very cloſely both to the outer and muſcular coat. One of them is hid by the adheſion of the meſocolon; and all the three divide the caecum longitudinally into three parts more or leſs equal.

They all unite on the appendicula vermiformis, and cover its whole outer ſide immediately under the common coat. Though they appear exteriorly on the caecum to be ligamentary, they are made up anteriorly of fleſhy fibres which accompany and ſtrengthen the longitudinal fibres of the muſcular coat.

The

The villous ſubſtance of the inner coat of the caecum is very ſhort, and furniſhed in ſeveral places with glandular lacunae or ſolitary glands, broader than thoſe of the ſmall inteſtines.

Theſe glandular lacunae or folliculi are flattened and depreſſed in the middle like ſmall pox. When we blow through a pipe into theſe lacunae without touching them, the folliculi are inflated, and repreſent little cups with a hole in the middle of their convex ſide.

§ 8. *Inteſtinum colon.*

Situation and ſtructure of the colon. The colon is the moſt conſiderable of all the inteſtines. From the caecum, of which it is a continuation, it reaches, in form of an arch, above the umbilical region, and to the lower part of the left hypochondrium. Its continuity is, however, a little interrupted by the ileum, which advances into the cavity of the colon, and, together with a certain fold of that inteſtine, forms what is called *valvula coli.*

The whole convex ſide of the colon is divided longitudinally into three parts, by three muſcular bands, firſt known to Sylvius and Euſtachius, continued from, and of the ſame ſtructure with, thoſe of the caecum. Two of theſe bands run on each ſide along the great curvature of the colon; and the third along the ſmall curvature.

The uppermoſt band of the two that belong to the great curvature is the broadeſt of the three; that which belongs to the ſmall curvature is the narroweſt, and it lay hid by the connection of the meſocolon, till it was brought to light by M. Morgagni.

Theſe three longitudinal bands do the office of longitudinal fraena, between which this inteſtine is, through its whole length, alternately depreſſed into tranſverſe folds, and raiſed into

into conſiderable eminences. All the folds are duplicatures, which form portions of valvulae conniventes in the cavity of the inteſtine; and the eminences form receptacles, called the *cells of the colon*.

All the coats of the colon concur equally to the formation of theſe duplicatures and cells, the depth of which decreaſes gradually toward the extremity of the inteſtine, and neither of them go any further than the ligamentary bands.

Theſe portions of the colon, which are immediately covered by the ligamentary bands, are ſmooth, and without rugae; and therefore, if theſe bands alone are cut acroſs, the inteſtine is not ſufficiently elongated to deſtroy all the folds and cells.

The common coat on one ſide is a continuation of the meſocolon, and on the other ſide it contributes, by the ſame continuation, to form the omentum. The longitudinal fibres of the muſcular coat are very ſlender, excepting in the bands already mentioned; and thoſe which anſwer to the annular or circular fibres of the ſmall inteſtines, are only ſegments ſtretched over the eminences and folds. The other coats are nearly as in the caecum; only the glandular lacunae or ſolitary glands are broader and more numerous.

The arch of the colon begins under the right kidney, near the haunch. It runs up on the foreſide of that kidney to which it is connected; paſſes under the veſicula fellis, which tinges it with a yellow colour at that place; and continues its courſe before the firſt incurvation of the duodenum, to which it adheres, and partly hides it. In this part of its courſe, therefore, there is a remarkable connection between the colon, duodenum, right kidney, and veſicula fellis.

From thence the arch of the colon runs before the great convexity of the ſtomach, and ſometimes a little lower; it then turns backward under the ſpleen, in the left hypochondrium; it runs down on the foreſide of the left kidney, to

which

which it is connected; below this kidney, it turns toward the vertebrae, and terminates there by a double incurvature, or by two oppoſite convolutions, which repreſent in ſome meaſure an inverted Roman S.

Theſe laſt convolutions of the colon are ſomewhat multiplied, and even advance to the right ſide of the pelvis; and along the great arch, and the two laſt incurvations, there are a kind of fringes, called *appendices coli adipoſae*, which we ſhall afterwards explain, as alſo the connections of the colon with the meſocolon and omentum.

Valvula coli. At the place where the caecum joins the colon, one portion of the circumference of both is depreſſed, and forms a large fold on the inſide, which advances into the cavity of the inteſtine, and gets the name of *valve* of the *ileum*, of the *caecum*, or of the *colon*. Some have named it after Bauhin, who is ſaid to have diſcovered it accidentally in Paris in 1579, by throwing water into the inteſtines, and finding that the paſſage was obſtructed at the end of the ileum; but Vidus Vidius deſcribed it ſeveral years before this. It is a little open in the middle, and its extremities are very thick, by the mutual duplicature of the coats of the caecum and colon.

The extremity of the ileum is as it were grafted in the opening of this fold, and ſtrongly united to its ſides by the adheſion of its tranſverſe fibres to the tranſverſe fibres of the caecum and colon.

This union forms a thick ring, which likewiſe advances into the common cavity of the caecum and colon, where it is wrinkled or formed into gathers, almoſt like the lower extremity of the oeſophagus, the pylorus, or inſide of the anus. Its circumference is more or leſs oval; and, by a kind of continuity with the common fold of the caecum and colon, it forms two productions, which M. Morgagni calls the *retinacula valvulae Bauhini*.

The membranous coat of the extremity of the ileum is continued on the caecum and colon, without ſinking into any fold at the place where the ileum enters the colon. The longitudinal fibres of the muſcular coat ſeem here to be confounded with the neareſt circular fibres of the caecum and colon.

The inner portion of the muſcular coat of the ileum runs in between the circular fibres of the ileum and colon, as into a common fold of theſe two inteſtines; from all which a thick ſhort portion of a fleſhy tube is formed, which is the circular riſing already mentioned.

The tunica nervoſa and villoſa of the extremity of the ileum likewiſe enter the common cavity of the caecum and colon, and on the edge of the circular riſing join the like coats of theſe two inteſtines; ſo that the circular riſing or ſhort muſcular tube is covered, both on the outer and inner ſides by a nervous and villous coat; that on the ſide being ſupplied by the ileum, and the other by the two great inteſtines.

The ſituation of this extremity of the ileum is moſt commonly tranſverſe, and is inſerted almoſt in the ſame direction in the common cavity of the two inteſtines already mentioned; but it is often a little more inclined toward the caecum than to the colon; and whereas, in all other places, the ileum is wide, and eaſily dilatable, it is very narrow at its inſertion, and its ſides are more ſolid and firm.

It is chiefly in this ſtructure that the mechaniſm of the inſertion of the ileum in the caecum and colon conſiſts; about which inſertion or opening authors are very much divided, ſome reckoning it a valve, others only a ſphincter.

It is very evident, from what we have ſaid, that it is a double machine, contrived to hinder the return of the excrements into the ileum, becauſe it can produce this effect partly as a valve, and partly as a kind of ſphincter. The

dried

dried preparations of this part give a very falſe idea of its ſtructure and conformation; and the ſame thing is to be ſaid of the opening of the appendicula vermiformis into the caecum.

The capacious arch of the colon is connected by both extremities to the regio lumbaris, near the kidneys, by two particular ligaments, one on the right ſide, the other on the left, which are only ſmall duplicatures of the peritonaeum, more or leſs tranſverſe.

The remaining portion, which forms the two convolutions in form of the Roman S, contracts below the left kidney, being narrower there than lower down. The coats of this portion become gradually thicker and ſtronger, and likewiſe the ligamentary bands, which approach each other by degrees, and ſeem to increaſe in breadth.

The veſſels, nerves, &c. will be found in the deſcription of the meſentery.

§ 9. *Inteſtinum Rectum, and Anus.*

Situation, figure, and ſize of the rectum The laſt of all the inteſtines is named *rectum*, or the *ſtraight gut*, from its ſituation; for when viewed directly forward, it appears to run down in a ſtraight courſe from the laſt vertebra of the loins, on the foreſide of the os ſacrum, all the way to the os coccygis, where it ends in what is called the *anus*.

This inteſtine, properly ſpeaking, is a true continuation of the laſt convolution of the colon; and it is the repoſitory, ſink, and common ſewer, of the whole inteſtinal canal. It has likewiſe a ſpecial relation to the bladder, and to the parts of generation in both ſexes.

The rectum having paſſed below the laſt vertebra of the loins, to the inſide of the os ſacrum, is bent backward, on that concave ſide to which it is connected, in the manner that

that ſhall be afterwards explained; and having reached the os coccygis, it runs likewiſe in the direction of that bone, and bends a little forward, terminating beyond the extremity of the coccyx.

The figure of this inteſtine varies according as it is full or empty. When empty, it is irregularly cylindrical, and ſinks in by a kind of tranſverſe folds; and in that ſtate it is about three fingers breadth in diameter, more or leſs. When full, it is wider in proportion to the quantity of faeces, wind, or whatever elſe is contained in it; and it may be extended to the ſize of a large bladder, ſo as to repreſent a kind of ſtomach.

Structure of the rectum. The membranous coat often contains a great quantity of fat, ſpread between it and the muſcular coat, and forming round the inteſtine numerous eminences, in the room of the appendices adipoſæ of the colon, which ſhall be explained in the hiſtory of the omentum.

The muſcular or fleſhy coat is very thick; and the longitudinal fibres, which in the other inteſtines are very thin, are in this ſtronger than the circular fibres of the reſt. The ligamentary bands continue to increaſe in breadth, and to approach each other, as has been ſaid; and it is to the fleſhy fibres of theſe bands that the thickneſs of the longitudinal fibres ſeem to be owing.

The nervous or filamentous and internal coats are larger here than in the other inteſtines; and, when the rectum is empty, they form a great number of waving rugæ in its cavity, which diſappear in proportion as that cavity is filled.

The innermoſt coat is very improperly termed *villoſa*, and ſcarcely deſerves the name of *papillaris*, becauſe of the ſmallneſs of the little corpuſcles ſpread on its ſurface. It contains a great number of ſingle or ſolitary glands; and it is always moiſtened by a mucus of different conſiſtencies, diſcharged by theſe glands or folliculi, and perhaps by the corpuſcles alſo.

Near

Near the extremity of this inteſtine the rugae or folds become in a manner longitudinal; and at laſt, towards the circumference of the inner margin of the anus, they form little bags or ſemilunar lacunae, the openings of which are turned upward, toward the cavity of the inteſtine. Theſe lacunae are ſomething like thoſe of the lower extremity of the oeſophagus or upper orifice of the ſtomach.

Muſcles of the anus. At length the extremity of the rectum contracts, and terminates by a narrow orifice called the *anus*, the ſides of which are diſpoſed in cloſe folds or gathers.

This extremity of the inteſtine has ſeveral muſcles belonging to it, ſome of which ſurround it like ſphincters; the reſt are broad fleſhy planes inſerted in it, and which, being likewiſe fixed to other parts, ſuſtain it in its natural ſituation, and reſtore it to that ſituation after being diſturbed by the force neceſſary for the excluſion of the faeces. Theſe latter muſcles are termed *levatores ani*; the firſt go by the general name of *ſphincters*. See deſcription of Muſcles in Vol. I.

§ 10. *Meſenterium et Meſocolon.*

Diviſion of the Meſentery, &c. This great bundle of inteſtines is not left to move at random in the cavity of the abdomen; but artfully bound down by a membranous web, which prevents the inteſtinal convolutions from being entangled in each other, and from being twiſted or compreſſed in all their different ways of meeting; and yet allows them a gentle floating, but limited motion.

This web goes ſtill by the antient Greek name of *meſentery*, as being in ſome meaſure in the middle of the inteſtines. It is diſtinguiſhed into two portions; one of which being very broad, and very much plaited, connects the ſmall inteſtines; the other, which is long and incurvated, does the ſame office to the great inteſtines.

Theſe

Theſe two portions are in reality only one and the ſame continuation of the membranous lamina of the peritonaeum doubled back upon itſelf, and they are diſtinguiſhed only by their breadth. Taken both together, they form a kind of ſpiral roll, more or leſs plaited in its circumference. The firſt portion has retained the name of *meſentery*; the other is termed *meſocolon*.

Structure of the meſentery, &c. The meſentery begins at the laſt incurvation of the duodenum, and runs obliquely from left to right along the vertebrae of the loins. In this ſpace, the membranous portion of the peritonaeum is detached on both ſides, produces a duplicature by two elongations or particular laminae applied to each other, and thus forms the meſentery.

It is narrower at its upper and lower parts, but chiefly at the upper. The middle portion is very broad, and the edge of it next the inteſtines is every where very much plaited. Theſe plaits or folds are only waving inflexions, ſuch as may be obſerved in the edge of a piece of ſhamoy which has been often drawn through the fingers. They make this edge of the meſentery very long, and they run through about one third of its breadth.

The two laminae are joined together by a cellular ſubſtance, which contains glands, veſſels, and nerves, that ſhall be deſcribed hereafter; and in ſome ſubjects it has a great quantity of fat, which keeps the two laminae at a good diſtance from each other.

Along the whole circumference of the meſentery, the two laminae are naturally ſeparated, and applied to the two ſides of the ſmall inteſtines, which they inveſt by their union, or rather reciprocal continuation on the great curvature of that canal, and carry it as in a ſcarf or ſling. This is what forms the external or membranous coat of the inteſtines.

The

The mesocolon is the continuation of the mesentery; which having reached the extremity of the ileum, contracts and changes its name. At this place, the particular lamina, which is turned to the right side, forms a small transverse fold, called *ligamentum coli dextrum*.

Afterwards the mesocolon ascends toward the right kidney, where it seems to be lost by the immediate adhesion of the colon to that kidney, and to the first incurvation of the duodenum. Then it appears again, and, increasing in breadth, it continues its course almost transversely under the liver, stomach, and spleen, where it begins to turn downward, under the left hypochondrium, toward the kidney on the same side.

Through this whole course the mesocolon extends in breadth, and forms nearly a transverse semicircular plane, very little plaited at its great circumference. By this circumference or edge, it is connected to the colon, and hides that ligamentary band of this intestine, which runs along its small curvature. By its short or small edge, it forms the triangular case of the duodenum; and, by its great edge, the external coat of the colon, in the same manner as the mesentery does that of the small intestines. As it passes under the large extremity of the stomach, it adheres a little to the lower portion of that extremity, as the diaphragm does to the upper.

Having got below the left kidney, it contracts, and forms another transverse fold, called *ligamentum coli sinistrum*. Afterwards it expands again, but not so much as in the upper part, and runs down on the left psoas muscle, toward the last vertebra of the loins. This descending portion is fixed to the convolutions of the colon, in the same manner as the superior portion is to the arch of that intestine.

The intestinum rectum is likewise invested by a particular production of the peritonaeum, commonly called by the name

of

of *meſo-rectum*. This production is very narrow, and about the middle of the fore-ſide of the rectum, it forms a tranſverſe ſemicircular fold, which appears when the inteſtine is empty, but is loſt when it is filled.

Between the laminae of the meſentery, a great number of glands lie ſcattered through the cellular ſubſtance. In the natural ſtate, theſe glands are ſomething of the figure of lentils or little round beans, ſome of them being orbicular, others oval, but all of them a little flatted, and in corpulent ſubjects we find them ſurrounded with fat.

Theſe glands are of the number of thoſe that anatomiſts call *glandulae conglobatae*, the ſtructure of which is not as yet ſufficiently known. They ſeem to be of a cellular ſubſtance, ſurrounded by a very fine membrane or coat, on which, by the help of microſcopes, we diſcover an intertexture of particular filaments, which Malpighi believed to be fleſhy fibres.

The niceſt anatomical injections have not hitherto given us any ſatisfaction about theſe particulars; for though they be made with all poſſible care, they always fill the folliculous texture of theſe glands; and though, by means of theſe injections, we may diſcover a great many veſſels which were before inviſible, we are not a whit the nearer our purpoſe, becauſe we cannot, by this method, diſtinguiſh the ſecretory, excretory, and blood-veſſels from each other.

Beſides the blood-veſſels, which are diſtributed in a reticular manner in the meſenteric glands, and beſides many nervous filaments ſpread through them, we diſcover an infinite number of ſmall lymphatic veſſels running from gland to gland.

Theſe veſſels are extremely thin and tranſparent, and furniſhed on the inſide with numerous valves, which appear on the outſide like little ſmall knots very near each other. They go out from each gland by ramifications, as by ſo many roots;

roots; and having formed a ſmall trunk, they are again divided, and enter ſome neighbouring gland by the ſame kind of ramifications by which they went out from the former.

Lacteal veſſels. Theſe are termed *lymphatic veſſels*, becauſe for the moſt part they contain a very clear, limpid, though mucilaginous ſerum, called *lympha* by anatomiſts. But as they have likewiſe been obſerved to be filled with a white milky fluid, called *chyle*, they have been called *vaſa chylifera*, or *venae lacteae*. They have the name of *veins*, becauſe their valves are diſpoſed as thoſe of the ordinary blood veins, and becauſe the fluid which they contain runs from ſmaller into larger tubes: But the particular deſcription of theſe will come in more properly in a latter part of the work.

§ 11. *The Blood-veſſels and Nerves of the Inteſtines.*

Blood-veſſels of the Inteſtines. The duodenum has commonly a particular artery, called *duodenalis* or *inteſtinalis*, which comes indifferently from the ſtomachica coronaria, pylorica, gaſtrica major, or hepatica. It has likewiſe ſeveral diſtinct ramifications from theſe trunks, and from the meſenterica ſuperior and ſplenica; which ramifications communicate with each other.

The arteria duodenalis, and the other additional ſmall arteries, form a vaſcular net-work round the muſcular coat of the inteſtine, which ſends out a great number of capillaries toward both the outer and inner ſides, that make the whole inteſtine look of a red colour.

The veins of the duodenum are ramae of the vena portae, and the diſtribution and denomination thereof is much the ſame with that of the arteries; only they communicate more with each other than the arteries, and alſo with the great haemorrhoidal vein.

The venal ramifications form round the duodenum a network like that of the arteries; and the ſame kind of vaſcular texture is more or leſs to be found in all the other inteſtines.

The arteries of the jejunum come chiefly from the meſenterica ſuperior, and ſome from the aſcending branch of the meſenterica inferior. The veins for the moſt part open into the great meſeraica; and the reſt go into the ſplenica and ſmall meſeraica or haemorrhoidalis interna.

The principal ſubaltern trunks of theſe arteries and veins accompany each other through the cellular ſubſtance between the laminae of the meſentery; are diſtributed by branches and rami; and form the meſhes, lozenges, and arches, which ſhall be mentioned in the deſcription of the arteries and veins. The laſt of theſe arches and lozenges, or thoſe next to the inteſtine, produce two ſmall vaſcular planes, which ſeparate from each other very diſtinctly, and ſurround the inteſtinal canal in a reticular manner.

The blood-veſſels of the ileum have the ſame ſources with thoſe of the jejunum; and it ought to be obſerved concerning both theſe veſſels, and thoſe of the jejunum, that in their whole courſe through the meſentery, they give ramifications to the glands, laminae, and cellular ſubſtance of the meſentery; and alſo, that there is a kind of communication between ſeveral ſmall meſeraic veins and the capillary rami of the venae lumbares and ſpermaticae.

The arteries of the caecum and appendicula vermiformis are ramifications of the laſt branch from the convex ſide of the meſenterica ſuperior; and they have likewiſe ſome ſmall ones from the ſecond and third branches, when both are found. The veins of theſe two parts are ramifications of the great meſeraica; and one of theſe rami is by Riolan termed *vaena caecalis*.

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The ſtraight portion of the arch of the colon, or that which is an immediate continuation of the caecum, is ſupplied with arteries by the ſecond branch that comes from the concave ſide of the meſenterica ſuperior, and likewiſe a little by the third, when there is a third.

The ſuperior or middle portion of the arch of the colon is furniſhed by the firſt branch from the ſame ſide of the meſenterica ſuperior, which, by a bifurcation, communicates on both hands with the other portions of the arch of the colon.

The left portion of this arch derives its arteries partly from the firſt branch of the ſame meſenterica, and partly from that of the meſenterica inferior; which two branches form the celebrated communication or common arch of the two meſentericae.

By means of this communication or continuation, in caſe one artery ſhould be obſtructed or compreſſed, the other would furniſh blood to all the branches below the place of the obſtruction. The ſecond branch of the meſenterica inferior, gives likewiſe ſmall arteries to the left extremity of the colon.

The deſcending convolutions of the colon, which repreſent a Roman S, are ſupplied by the other branches of the meſenterica inferior, the laſt of which forms the haemorrhoidalis interna.

The veins of all theſe portions of the colon form trunks which terminate chiefly in the haemorrhoidalis interna or meſaraica minor and major, and likewiſe in the vena portae ventralis. The diſtribution of theſe branches and ramifications is in ſome meaſure the ſame with that of the arteries, as may be ſeen in the deſcription of the veins.

The arteries of the rectum are furniſhed by the haemorrhoidalis interna, the laſt branch of the meſenterica inferior, which communicates with the hypogaſtrica, and particularly with

with the haemorrhoidalis externa, a production of one of theſe arteries.

The veins of the rectum go to form the beginning of the meſeraica minor or haemorrhoidalis interna; and they communicate with the haemorrhoidales externae, which are rami of one of the hypogaſtricae. They communicate likewiſe with the capillary ramifications of the other hypogaſtric veins, which come from the internal parts of generation of both ſexes.

It is here to be obſerved in general, that there is a ſucceſſive continuation, more or leſs ſimple or multiplied, between all the arteries of the inteſtinal canal, and likewiſe between all the veins; and alſo, that the veins are here thinner and more capacious than the arteries, in a greater proportion than in the other parts of the body.

Nerves of the inteſtines. The nerves of the duodenum are the middle plexus of the ſemilunar ganglion, and ſome filaments of the plexus ſtomachicus and hepaticus.

The nerves of the jejunum, ileum, and meſenteric glands, are the plexus meſentericus ſuperior, the poſterior meſenteric faſciculi, and the plexus meſentericus inferior.

The nerves of the caecum are the poſterior meſenteric faſciculi or plexus, and the plexus meſentericus inferior.

The nerves of the arch of the colon are the ſame faſciculi, and the two plexus meſenterici.

The nerves of the laſt convolutions of the colon are the poſterior meſenteric faſciculi, and the plexus meſentericus inferior and ſub-meſentericus.

The nerves of the rectum are the plexus meſentericus inferior, plexus ſub-meſentericus or hypogaſtricus, and the two ganglions of that plexus.

The nerves of the anus, and of its muſcles, are the ganglions of the plexus ſub-meſentericus, the inferior rope of both

both ſympathetici maximi, and the common arch of the extremities of both ropes.

§ 12. *Digeſtion.*

WITHIN the human ſtomach we find great quantities of mucus, ſpread upon its villous coat, and not unfrequently tinged by ſome of the bile returning into the ſtomach. Beſides this mucus, we find, eſpecially in an empty ſtomach, a limpid humour, of the ſame nature with the ſaliva, but rather more mucous. When it can be had pure and unmixed with the food, (which it may, by bending the body forward when it returns through the oeſophagus into the mouth) it is by no means acid. Left to itſelf, when untainted with the acid illuvies of the aliments, it is changed into a lixivial nature, both in men and brutes, eſpecially in hungry animals. This liquor diſtils from the arteries of the ſtomach, through its villous coat, as we ſee by anatomical injections, by which water, iſinglaſs, and oil, may be eaſily urged into the veſſels of the ſtomach, ſo as to ſweat through its numerous pores.

The ſtomach being contained within the cavity of the abdomen, which is always full, will be preſſed on every ſide by the diaphragm and abdominal muſcles; and the more it is filled the greater will this preſſure be, both on account of the diſtention of the integuments of the abdomen, and the altered ſituation of the ſtomach, which, when full, touches the peritonaeum at right angles.

Both the pain of hunger, and the pleaſure of gratifying the appetite, excite us to the performance of an action abſolutely neceſſary for our ſupport, viz. the taking a due portion of aliment in order to counterbalance the waſte of the body by the inſenſible perſpiration and other evacuations. This neceſſity of frequently taking food is increaſed by the blood, which being naturally of a ſaline quality, ſoon acquires an acrimonious

acrimonious putrefcency, by the evaporation of its thin watery parts; and this evaporation being increafed by the heat of the body, and the motion of the heart and arteries, nature calls ſtrenuouſly for a recruit of the watery element, by which the cohefive globules of the blood are ſeparated from each other, and hindered from running together into a ſolid maſs.

Theſe truths are proved, not only from their cauſes, but likewiſe by the appearances which they exhibit in men and other animals ſtarved to death. For, in ſuch, we commonly obſerve the breath ſharp and fetid, the teeth looſened by the diſſolving acrimony of the juices, violent pains in the ſtomach, acute fevers, and even madneſs. All theſe diſorders ariſe ſooner and ſtronger, as the perſon is more robuſt and more accuſtomed to exerciſe; but they enſue very ſlowly in phlegmatic people, who are unactive, perſpire little, and put the blood into no great motion. Laſtly, thoſe who have lived ſome time without food and bodily exerciſe have, for the moſt part, laboured under a diſeaſe of the nerves.

The freſh chyle, prepared, for the moſt part, from aceſcent vegetable food, is of a conſiſtence always thinner than that of the blood itſelf; being received into the circulation, it temperates the putrefcent acrimony, dilutes the threatened coagulation, and reduces the whole maſs to that moderate degree of ſaline nature which is natural to man: And finally, the chyle, but more eſpecially that derived from animal food, and likewiſe what is formed of farinaceous vegetables, being repleniſhed with gelatinous lymph, ſerves to repair the conſumption or waſte which is made from the body itſelf, to the vacuities of whoſe broken ſolids it is applied by the cauſes which promote the growth of the body. The drink dilutes the cohefive diathefis of the blood, hinders its putrefaction, and carries off by the emunctories ſuch particles as are already putrid: And hence it is

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that a perſon may live for a long time without ſolid food, if he is ſupplied with drink; but, without drink, life ſubſiſts but a few days.

We are ſolicited, as was ſaid above, to take food, as well from the ſenſe of pain we call hunger, as from the pleaſure received by the taſte. The firſt of theſe proceeds doubtleſs from the folds or plicae of the ſtomach, whoſe ſenſation is extremely acute, rubbing againſt each other by the periſtaltic motion, and from a preſſure of the diaphragm and abdominal muſcles, by which the naked villi of the nerves on each ſide of the ſtomach are made to grate againſt thoſe of the other, producing, at the ſame time, an intolerable ſenſe of pain. Thus, we are effectually admoniſhed of the dangers enſuing from too long abſtinence or faſting, and excited to procure food or nouriſhment by labour and induſtry. The gaſtric liquor, becoming acid from faſting, may alſo perhaps conduce to excite the ſenſe of hunger; but it will not produce any effect if it is putreſcent.

Thirſt is perceived by the tongue, fauces, oeſophagus, and ſtomach. For, whenever theſe very ſenſible parts, which are conſtantly and naturally moiſtened by mucous and ſalival juices, grow dry from a deficiency of theſe or ſimilar humours, or are irritated by a redundancy of muriatic or alkaleſcent ſalts, a ſenſe called thirſt, which is much more intolerable and dangerous than the former, ariſes; this diſagreeable ſenſation continues until the proportion of diluting water in the blood, being recruited, reſtores the neceſſary moiſture and free ſecretion required in the parts before mentioned. From hence we learn why thirſt attends labour, which exhales a greater proportion of the watery perſpiration; and why it is a ſymptom of fevers, where there is an obſtruction of the exhaling veſſels belonging to the tongue and fauces; and why ſimple water is leſs efficacious in abating thirſt than acid liquors, that not only moiſten and render fluid, but alſo,

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by their mild irritation of the tongue and mouth, provoke forward the humours, and at the ſame time correct their putrid tendency.

Being under the neceſſity of ſeeking food for the ſupport of life, we have choſen it from a great variety of both animals and vegetables, adding to each of them certain portions of water and ſalt, either to aſſiſt their ſolution, or render them more ſapid. It is probable that the primitive choice of our foods was made by experiments, according as the variety of ſmells and flavours in vegetables and their ſeveral parts invited us, and as the ſtrength or recruit of our faculties, from their uſe, confirmed their utility. But, by degrees, animals increaſing ſo much as to be incommodious to the huſbandman, and vegetables alone not being ſufficient for ſupporting them under their labours, the fleſh of animals was afterwards added. At preſent, both the number and variety of ſubſtances are almoſt infinite, which we take either as food or ſeaſoning for our nouriſhment.

Although there are many inſtances of particular perſons, and even of whole nations, who have ſupported life only with one kind of food, either vegetable or animal, or even from a ſmall claſs of either of them; and, laſtly, though ſome have lived altogether upon milk, or its whey; yet it ſeems to be neceſſary, both from the nature and fabric of the human body itſelf, as well as from certain experiments, that we ought to ſupport life by the different kinds of food, ſo intermixed, that none of them may exceed their reaſonable bounds; and this mediocrity we are taught from the loathing which follows any one kind of food continued for too long a time together.

Animal food appears a neceſſary part of our nouriſhment, from the fabric of the human ſtomach reſembling that of carnivorous animals; and from teeth being inſerted into each jaw; from the ſmallneſs and ſhortneſs of the inteſtinum caecum;

cum; and from the neceſſary vigour which we require. Animal food alone contains the gelatinous lymph ready prepared for the recruit both of our fluids and ſolids; and this lymph, extracted from the broken veſſels and fibres, eaſily paſſes in great abundance into the blood. An abſtinence from animal food generally cauſes great weakneſs both to the body and ſtomach, being perpetually attended with a troubleſome diarrhoea. In the ſize and length of the inteſtina craſſa, man agrees with herbivorous animals.

Eſculent vegetables are generally of the aceſcent kind; ſome few of them however are alkaleſcent or aromatic. Few of them have that animal glue which is ſpontaneouſly changeable into blood; for it is only the ſmall portion of jelly which is drawn from their farinaceous parts, that, after many repeated circulations, is converted into the nature of our proper juices. The uſe of vegetables is extremely neceſſary in order to prevent too great quantity of blood, and to hinder its putreſcency. Too much animal food produces, as we ſee more particularly in Athropophagi, the hot alkaleſcent ſcurvy, a fierce or ſavage temper, a peculiar fetor, and leproſy, with a lixivial corruption of all the juices; which are only to be cured by change of diet, in which a vegetable acidity abounds. Hence it is that we are furniſhed but with few canine teeth; and that our appetite in health, but more eſpecially in diſeaſe, is ſtronger for acidulous vegetables, in proportion to our warmer temperature of body, and greater heat of the country, or the ſeaſon of the year. Hence we ſee, that, in the hotteſt climates, people live either altogether upon vegetables, or uſe fleſh meats but very rarely, and not without danger of acute diſeaſes; while, in the colder countries, fleſh is eaten freely with leſs danger; and hence bread, or a farinaceous aliment ſimilar to it, is made a ſtanding part of our food throughout the world.

The beſt *drink* is afforded by pure water, not incorporated with ſalts, nor with air, which may excite fermentations. Of this kind we juſtly prefer that from a mountainous ſpring, which runs through a ſandy bed, and which is cold, clear, light, and inſipid. Whenever we are unprovided with ſuch pure water, as is frequently the caſe in low flat countries, or when any increaſe of the ſtrength and muſcular conſtriction of the ſtomach is required from a ſpicy ſtimulus, its place may be very well ſupplied by wine, prepared chiefly from grapes; but, in defect of thoſe, from apples and pears; which, after a due fermentation, becomes clear, and is repleniſhed with an acid ſalt, and oily or inflammable ſpirit, well diluted with water. Liquors of the ſame kind, replete with a vinous or inflammable ſpirit, but more flatulent, heavy, and leſs palatable, are extracted by boiling water from grain of different kinds previouſly malted, and prepared by fermentation, as ſubſtitutes for wine in thoſe countries where the grape does not ripen.

Mankind have invented various pickles and ſauces, as ſalt, vinegar, and acids of various kinds, to correct the putreſcent diſpoſition of fleſh-meats; and pepper, and other hot ſpices, to ſtrengthen the action of the ſtomach, which is perpetually weakened by the uſe of vegetables: To theſe we may add ſugar, and the eaſtern ſpices, which are generally uſed either for the ſake of flavouring or preſerving our food. But all theſe yield no nouriſhment, being deſtitute of all gelatinous lymph, or any farinaceous quality.

The aliments are variouſly prepared, according to the difference of country, climate, or ſeaſon; and thus their crudity is removed, their ſolid fibres ſoftened, their ſuperfluous air expelled, and their diſagreeable acrimony changed and rendered agreeable. But, even after this, many vegetable foods, and more eſpecially fleſh-meats, require to be divided, in ſome degree, by previous maſtication, which is particularly neceſſary

neceſſary in man, whoſe ſtomach has but few and weak muſcles Previous maſtication alſo aſſiſts digeſtion, and therefore prevents the food from ſtaying ſo long upon the ſtomach as to become putrid.

The meaſure of our food is determined by hunger, which is different in different circumſtances. Animal and farinaceous food nouriſhes moſt: Other aliments ought to ſupply, by their quantity, what they want in their powers of nouriſhment. In general, we are nouriſhed beſt by a ſomewhat ſpare diet, unleſs we are ſubjected to much labour.

Aliments of various kinds are received into the ſtomach, either whole or maſticated. Some of them are alkaleſcent, as animal ſubſtances; others ranceſcent, as fat; others aceſcent, as vegetables; and others glutinous, as milk, bread, and moſt of the farinaceous ſeeds. The aliments are digeſted in a heat nearly equal to that neceſſary for hatching an egg, produced by the circumjacent liver, ſpleen, and other viſcera. During digeſtion, the ſtomach is perfectly cloſed, both at its ſuperior, and inferior orifices; and, although the muſcular fibres of the ſtomach contract, yet no food is propelled into the inteſtines, until it has been thoroughly digeſted; even milk itſelf is often retained in the ſtomach of ſtrong animals ſeveral hours after a meal, without paſſing into the inteſtines. The aliments, either naturally containing air in themſelves, or mixed with air in maſtication, are macerated in the juices of the ſtomach. In conſequence of the heat, this included air is expanded, and by an operation ſomewhat ſimilar to fermentation, breaks the cells in which it was included, and thus the contents of the ſtomach are reduced to a pulpy ſtate. The ſolidity of animal ſubſtances is occaſioned ſolely by their being impregnated with air, and the air being extricated or ſet free in the ſtomach, theſe ſubſtances are reduceable to a friable or ſoluble ſtate. This laſt fact is illuſtrated by Papin's digeſter. This air, ſet at liberty by the digeſtion, often, un-

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der the denomination of flatus, diſtends the ſtomach more than the food itſelf. While it is extricated, the aliments begin to corrupt or change into a nauſeous liquid, often aceſcent, or otherwiſe putreſcent, which however happens leſs in mankind from our uſe of bread and ſalt. It is frequently ranceſcent, as appears from the flatus, and often of a moſt fetid, cauſtic, and inflammable nature. This putreſcency, or imperfect putrefaction, ſays Haller, is almoſt the only cauſe of digeſtion in fiſh, ſerpents, and carnivorous birds. Hence, in mankind, metals themſelves, by long ſtay in the ſtomach, grow ſoft, and are eroded; but, from Spallanzani's experiments, it appears that there are no ſigns of putrefaction in the time of digeſtion, except in ſick animals. (See Experiments on Digeſtion, &c.) During digeſtion there is no ſenſe of hunger, for the nervous plicae of the ſtomach are kept from grating on each other by the interpoſition of the food; and they are not affected by the gaſtric juice, which, in digeſtion, acts on the aliment.

The aliment is prevented from becoming completely acid, by the heat; by the gaſtric juices; by the ſaliva, which is rather alkaleſcent, and ſwallowed to the amount of half an ounce in an hour; and by the bile which frequently regurgitates into the ſtomach. There is no particular kind of ferment in the ſtomach; from which the deſign of nature, the diſpoſition of the ſtomach, and its uſe, are all very remote. And yet the juice of the ſtomach alone, eſpecially in fiſhes, diſſolves the bones of other fiſhes, which they had devoured. (See Spallanzani's Experiments).

To the preceding theory of digeſtion, taken from Haller, we ſhall add an abridged account of ſome experiments, extracted from the ingenious Mr Smellie's Philoſophy of Natural Hiſtory.

"Dr Stevens, in an Inaugural Diſſertation concerning Digeſtion, publiſhed at Edinburgh in the year 1777, made ſeveral

ſeveral experiments upon a German, who gained a miſerable livelihood by ſwallowing ſtones for the amuſement of the people. He began this ſtrange practice at the age of ſeven, and had at that time continued in it about twenty years He ſwallowed ſix or eight ſtones at a time, ſome of them as large as a pigeon's egg, and paſſed them in the natural way. Dr Stevens thought this poor man would be an excellent ſubject for aſcertaining the ſolvent power of the gaſtric juice in the human ſtomach. The Doctor, accordingly, made uſe of him for this purpoſe. He made the German ſwallow a hollow ſilver ſphere, divided into two cavities by a partition, and perforated with a great number of holes, capable of admitting an ordinary needle. Into one of theſe cavities he put four ſcruples and a half of raw beef, and into the other five ſcruples of raw bleak. In twenty one hours the ſphere was voided, when the beef had loſt a ſcruple and a half, and the fiſh two ſcruples. A few days afterwards, this German ſwallowed the ſame ſphere, which contained, in one cavity, four ſcruples and four grains of raw, and, in the other, four ſcruples and eight grains of boiled beef. The ſphere was returned in forty three-hours: The raw fleſh had loſt one ſcruple and two grains, and the boiled one ſcruple and ſixteen grains. Suſpecting that, if theſe ſubſtances were divided, the ſolvent would have a freer acceſs to them, and more of them would be diſſolved, Dr Stevens procured another ſphere, with holes large enough to receive a crow's quill. He incloſed ſome beef in it a little maſticated. In thirty eight hours after it was ſwallowed, it was voided quite empty. Perceiving how readily the chewed meat was diſſolved, he tried whether it would diſſolve equally ſoon without being chewed. With this view, he put a ſcruple and eight grains of pork into one cavity, and the ſame quantity of cheeſe into the other. The ſphere was retained in the German's ſtomach and inteſtines forty-three hours; at the end of which time, not the ſmalleſt quantity

of

of pork or cheeſe was to be found in the ſphere. He next ſwallowed the ſame ſphere, which contained, in one partition, ſome roaſted turkey, and ſome boilt ſalt herring in the other. The ſphere was voided in forty ſix hours; but no part of the turkey or herring appeared; for both had been completely diſſolved. Having diſcovered that animal ſubſtances, though incloſed in tubes, were eaſily diſſolved by the gaſtric juice, the Doctor tried whether it would produce the ſame effect upon vegetables. He therefore incloſed an equal quantity of raw parſnep and potatoe in a ſphere. After continuing forty eight hours in the alimentary canal, not a veſtige of either remained. Pieces of apple and turnip, both raw and boiled, were diſſolved in thirty ſix hours.

"It is a comfortable circumſtance, that no animal, perhaps, except thoſe worms which are hatched in the human inteſtines, can reſiſt the diſſolving power of the gaſtric juice. Dr Stevens incloſed live leeches, and earth-worms, in different ſpheres, and made the German ſwallow them. When the ſpheres were diſcharged, the animals were not only deprived of life, but completely diſſolved by the operation of this powerful menſtruum. Hence, if any live reptile ſhould chance to be ſwallowed, we have no reaſon to apprehend any danger from ſuch an accident.

"The German left Edinburgh before the Doctor had an opportunity of making a farther progreſs in his experiments. He therefore had recourſe to dogs and ruminating animals. In the courſe of his trials upon the ſolvent power in the gaſtric fluid of dogs, he found that it was capable of diſſolving hard bones, and even balls of ivory; but that, in equal times, very little impreſſion was made upon potatoes, parſnep, and other vegetable ſubſtances. On the contrary, in the ruminating animals, as the ſheep, the ox, &c. he diſcovered that their gaſtric juice ſpeedily diſſolved vegetables, but made no impreſſion on beef, mutton, and other animal bodies. From theſe

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laſt experiments, it appears that the different tribes of animals are not leſs diſtinguiſhed by their external figure, and by their manners, than by the quality and power of their gaſtric juices. Dogs are unable to digeſt vegetable, and ſheep and oxen cannot digeſt animal ſubſtances. As the gaſtric juice of the human ſtomach is capable of diſſolving, nearly with equal eaſe, both animals and vegetables, this circumſtance affords a ſtrong, and almoſt an irreſiſtible proof, that nature originally intended man to feed promiſcuouſly upon both.

" Live animals, as long as the vital principle remains in them, are not affected by the ſolvent powers of the ſtomach. ' Hence it is,' Mr Hunter remarks, ' that we find animals ' of various kinds living in the ſtomach, or even hatched ' and bred there; but the moment that any of theſe loſe ' the living principle, they become ſubject to the digeſtive ' powers of the ſtomach. If it were poſſible, for example, ' for a man's hand to be introduced into the ſtomach of a ' living animal, and kept there for ſome conſiderable time, ' it would be found that the diſſolvent powers of the ſtomach could have no effect upon it: But, if the ſame hand ' were ſeparated from the body, and introduced into the ' ſame ſtomach, we ſhould then find that the ſtomach would ' immediately act upon it. Indeed, if this were not the ' caſe, we ſhould find that the ſtomach itſelf ought to have ' been made of indigeſtible materials; for, if the living ' principle was not capable of preſerving animal ſubſtances ' from undergoing that proceſs, the ſtomach itſelf would be ' digeſted. But we find, on the contrary, that the ſtomach, ' which at one inſtant, that is, while poſſeſſed of the living ' principle, was capable of reſiſting the digeſtive powers ' which it contained, the next moment, viz. when deprived ' of the living principle, is itſelf capable of being digeſted, ' either by the digeſtive powers of other ſtomachs, or by the

' remains

'remains of that power which it had of digeſting other 'things.'

"When bodies are opened ſome time after death, a conſiderable aperture is frequently found at the greateſt extremity of the ſtomach. 'In theſe caſes,' ſays Mr Hunter, 'the 'contents of the ſtomach are generally found looſe in the 'cavity of the abdomen, about the ſpleen and diaphragm. 'In many ſubjects, this digeſtive power extends much farther 'than through the ſtomach. I have often found, that, af-'ter it had diſſolved the ſtomach at the uſual place, the 'contents of the ſtomach had come into contact with the 'ſpleen and diaphragm, had partly diſſolved the adjacent 'ſide of the ſpleen, and had diſſolved the ſtomach quite 'through; ſo that the contents of the ſtomach were found 'in the cavity of the thorax, and had even affected the 'lungs in a ſmall degree.'*

The fleſhy fibres of the ſtomach being irritated by the flatus, the weight, and the acrimony of the food, begin to contract themſelves more powerfully than when the ſtomach is empty, and with a greater force in proportion as it is more full. And, firſt, the muſcular ſtratum, which paſſes along the leſſer curvature, draws the pylorus to the oeſophagus; and, being inſerted only into the left face of the former, draws it to the right. The principal ſtratum of the circular fibres contracts the capacity of the ſtomach according to its length; grinds or intermixes its contents with the liquors; and determines them both, like the preſſure of two hands placed oppoſite, to flow towards the pylorus: But this flux through the pylorus is not continual, on account of the valvula pylori, and likewiſe becauſe this motion begins from ſome part that is more irritated, and, as we ſee by numerous experiments, part of it is very ſoon received into the blood. Theſe alternate contractions at laſt terminate in a full evacuation. In this action of the ſtomach, there is nothing

* See Smellie's Philoſophy of Natural Hiſtory.

thing which reſembles the triture made by the ſtrong gizzards of granivorous fowls, which ſome anatomiſts have aſcribed to the human ſtomach. The ſtomach, however, has a conſiderable degree of ſtrength, ſince the contraction of its fibres is often more than a third part of their length; for we frequently ſee the ſtomach reduced to leſs than a third part of its diameter. The ſtomach is alſo frequently obſerved to be diminiſhed to much leſs than its third part, even to the breadth of an inch, ſo that it can expel the ſmalleſt ſubſtances, and entirely evacuate itſelf. The compreſſing force of the ſtomach muſt be very ſmall, as it bruiſes neither berries nor worms.

The motions which the ſtomach receives from the diaphragm and abdominal muſcles is greater than its proper periſtaltic motion. It is principally by the force of theſe muſcles that the drinks are urged on continually, but the ſolid foods only when they are diſſolved, leſt thoſe parts which are too groſs ſhould be expelled through the pylorus into the duodenum; for the ſolid aliments do not ſeem to leave the ſtomach before they have changed their fibrous or other texture for that of a mucus; being, as it were, a cineritious, yellowiſh, ſomewhat fetid, mucilaginous, and liquid pulp. That which is firſt prepared and become fluid goes out of the ſtomach before the reſt; but, ſuch things as are hard, or too large to paſs the pylorus, are retained in the ſtomach for a longer time.

The ſtomach being irritated by too great a quantity or acrimony of the food, by ſickneſs, by a repulſion of the bile, or other cauſes, does, by an antiperiſtaltic or reverted motion of its fibres, drive its contents upwards through the open and relaxed oeſophagus in the act of vomiting. Any part of the whole inteſtinal canal, from the pharynx to the rectum, may be conſtricted, either ſuddenly or ſlowly, by an antiperiſtaltic motion. If it happens ſuddenly to the upper parts at the ſtomach, the diaphragm, and likewiſe the abdominal muſcles, being convul-

ſed at the ſame time, it is called *vomiting*; if it is ſlowly performed, it may be called *ruminatio*; if the ſmall, and particularly the great inteſtines, return their contents upwards, the diſeaſe is called *ileus*. The effect of vomiting is partly from the preſſure of the abdominal muſcles depreſſing the falſe ribs, and urging the contents of the abdomen againſt the diaphragm; which, at the ſame time, contracting itſelf to a plane downwards, forces the ſtomach, as between the ſides of a preſs, to throw up its contents.

The aliments driven in their natural courſe to the duodenum, meet there with the influent bile and pancreatic juice, which often flow back into the ſtomach.

A thin watery liquor diſtils from the exhaling arteries into the cavity of the inteſtines, like the juice of the ſtomach, not acrid, but ſaltiſh. The quantity of this liquor may be computed from the large extent or ſum of all the excretory orifices, and from the ſection of the ſecretory artery, which is larger than any other in the body; add to this, the laxity of the parts perpetually kept warm and moiſt, and the copious diarrhœa or watery diſcharge that often follows the uſe of purgative medicines. The mucus ariſing from the pores or cells, ſerves to lubricate and defend the internal ſurface of the villous membrane, and to guard the ſenſible nerves from ſtrongly acrid or pungent particles. Hence we ſee, it is more abundant at the beginning of the larger inteſtines, becauſe there the maſs of aliment begins to be more feculent, acrid, and tenacious.

The mixture of this liquor with the pulp-like maſs of the aliment, together with the bile and pancreatic juice, is made by the motion of the ſurrounding muſcles of the abdomen; but this force is ſmall, and incapable of moving the aliments forward. The periſtaltic motion, which is more particularly ſtrong and evident in the ſmall inteſtines, is the chief power by which the digeſted aliments are propelled along the inteſ-

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tinal tube. Any part of the inteſtine, irritated by flatus or any ſharp or rough body, contracts itſelf, even after death, moſt violently in that part where the ſtimulus is applied, in order to free itſelf from the offending or diſtending body, which it expels into the next open part of the lax inteſtine; where, being received, it is again propelled forward, by exciting a like ſtimulus and contraction as before. This contracting motion of the inteſtines is made in various parts of the gut, either ſucceſſively or at the ſame time, wherever the flatus or aliment excites a ſtimulus, without obſerving any certain order. So well fitted, however, are the inteſtines for this motion, that they even exceed the irritability of the heart. When they are not irritated, they remain at reſt; and we may ſuppoſe this to be the cauſe why the fat is depoſited in the abdomen. The principal ſtimulus is the air; next to that is the aliment; and, laſtly, the bile. This motion is performed by a ſort of alternate creeping and revolution of the inteſtines, which diſſection eaſily demonſtrates in brute animals, and caſes of wounds in the abdomen and ruptures have manifeſted it in the human ſpecies. Among ſo many inflexions, the weight of the aliment is but of little conſequence, for it eaſily aſcends or deſcends through the irritated inteſtine, which thus empties itſelf.

This periſtaltic motion of the inteſtines is performed by the conſtriction of their circular fibres, which empty the tube exactly, without injuring it againſt pins, needles, or any other ſharp bodies accidentally introduced into it, they being at the ſame time puſhed forward. But the revolutions, or thoſe motions in which the tube is alternately ſhortened and lengthened, and the ſtraightening of crooked parts one before another, which is ſo remarkably conſpicuous in brute animals, are performed by the long fibres, which we ſee contract themſelves at the ſeat of the preſent ſtimulus, and dilate the following portion, in order to receive what follows. By the ſame contraction,

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the villous membrane of the inteſtines, within their cavity, is urged and reduced into longer folds; whence the mucus is expreſſed and applied, by the force of irritation and ſtimulus, to that part of the alimentary maſs where it was required. Theſe long fibres frequently make intro-ſuſceptions of the inteſtines, and generally without any bad conſequences, by drawing up the contracted portion of the inteſtine into that which is looſe, in ſuch a manner, that the former is ſurrounded by the latter, which is relaxed.

The alimentary pulp, diluted with the pancreatic juice and that of the inteſtines, intimately mixed with the ſaponaceous bile and circumjacent mucus, is more perfectly diſſolved than it was by the efficacy of the ſtomach in proportion as the ſides of the inteſtines come into a larger contact, and approach nearer together; to which add, the longer ſeries of the periſtaltic motions, and the greater quantity of diſſolving juices. In this manner the alimentary pulp, intermixed with air, forms a froth, without any kind of fermentation. At the ſame time the acid or aceſcent quality is corrected, while the oily or fat parts, diſſolved by the bile, intermix with the watery juices, and give the chyle its uſual milky appearance. It is of a bright colour in the duodenum, at the firſt entrance of the biliary duct, and may be ſeen diſtinctly through the whole length of the ſmall inteſtines adhering to their villous coat. But the gelatinous juices of fleſh-meats, diluted with a large portion of water, and likewiſe from their own ſubviſcid nature, adhere more particularly to the villous coat, and enter it by abſorption. Water and watery liquors are all very ſpeedily abſorbed, and yet the feculent remains never grow thick in the ſmall inteſtines, as far as Haller has been able to obſerve, becauſe the watery part is repaired by the arterial vapour and mucus; nor do they become foetid in any conſiderable degree, as well becauſe of the great quantity of diluting juices, as becauſe the quick progreſſion will not allow them

them time enough for putrefying. Theſe remains, of a more earthy, groſs, and acrid diſpoſition, which were not received by the mouths of the abſorbing lacteals, by their own weight, or by the muſcular contractions, deſcend ſlowly into the large inteſtines, ſo as to complete their whole courſe in the ſpace of about twenty-four hours: All the chyle of the aliment, however, is commonly extracted within three or four hours, or a little more.

The conſiderable length of the ſmall inteſtine, which is upwards of five times longer than the body, the great ſurface of the villous membrane increaſed by folds, the incredible number of exhaling or abſorbent veſſels, the ſlow courſe of the feces through the large inteſtines, and the great quantity of the inteſtinal juice poured into the alimentary maſs, all conduce to the preparation of the chyle; to its abſorption into the lacteals and the meſenteric veins; to the abſtertion of viſcidities from the inteſtine; to the avoiding adheſions and coagulations; to the deſtruction of any acrid diatheſis; and to the ſubduing any poiſonous quality in many juices, which, being directly mixed with the blood, would inſtantly kill. Hence, in general, the inteſtines are long in animals that feed upon hard diet, but ſhort in carnivorous ones, and ſhorteſt in all thoſe that live upon juices: And, even in man, an uncommon ſhortneſs of the inteſtines has been known to be attended with hunger, and a diſcharge of foetid and fluid feces.

The heat by which the aliment is fomented, and which is exceedingly proper for the ſolution of the gelatinous matter, and for exciting a beginning putrefaction, is the principal cauſe of the foetor which is gradually produced in the aliment; hence alſo the uſeful part of the aliment, rendered more fluid, is the better adapted for abſorption. The air alſo, incloſed in the viſcid aliment, operates here, as in the ſtomach, by breaking the coheſion of the aliments, if any parts of it

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yet remain whole. The inteſtinal water dilates the little maſſes of aliment; and if any hard part remains, this liquor ſoftens it by maceration. The bile being intimately mixed with oil, renders it miſcible with water.

What remains, after the chyle has been abſtracted, conſiſts of ſome portion of the bile, become mucilaginous, and degenerated; ſome part of the human mucilages; moſt of the earthy parts of the food; all thoſe parts which, by their acrimony, were rejected by the abſorbing mouths of the lacteals, yet changed by means of putrefaction; and laſtly, all the ſolid fibres and membranes, whoſe coheſion was too great to be overcome by the maceration and periſtaltic motion in the inteſtines.

All theſe remains paſs from the extremity of the ileum into the caecum, in which they are collected.

The inteſtinal feces, therefore, retained in the beginning of the colon, or large inteſtine, there grow dry by the abſorption of their vapours, ſo as to be capable of receiving a figure from the round contracted parts of the colon; they aſcend from the bottom of the caecum elevated by the long ligaments, which end in the appendix vermiforis. And here the manner in which the feces are propelled by the contraction of the circular fibres, appears better than in the ſmall inteſtines. The longitudinal fibres of the inteſtine, being attached to the contracted parts as fixed points, draw up and dilate the lower parts of the inteſtine; the parts of the inteſtine, to which the feces are next brought, being irritated and contracted in like manner, are immediately after drawn together by the round and long fibres, by a ſucceſſive repetition of which the feces finiſh their courſe, through the whole large inteſtine, in about twenty-four hours in a healthy perſon.

While the groſs feces aſcend by the folds or valves of the ileum, the weight of them depreſſes the lower fold to the left

ſide,

ſide, which draws back the ligament common to each valve, in ſuch a manner as to compreſs and exactly cloſe the upper fold downward, that nothing may return back into the ileum; which might eaſily happen in a fluid ſtate of the feces, if this paſſage was not ſo accurately ſhut up. The feces, when in danger of falling down from the upper parts, depreſs the upper valve, and thus accurately exclude themſelves. The feces continue to move ſlowly forward, becoming more dry, conſiſtent, and figured by the ſame cauſes, through the whole tract and repeated flexures of the colon. This inteſtine is from five to ſeven feet long, and it is in general capable of retaining the feces for twenty-four hours, ſo as to give no interruption to the common affairs of life; this retention, however, is always proportional to the velocity with which the ſmall inteſtines propel their contents.

At length the feces fall into the rectum, which being ſituated in the midſt of much ſurrounding fat and cellular ſubſtance, eaſily expands, and ſuffers the excrement to be collected in large quantities, and to be retained for a conſiderable time.

The ſtructure of the rectum differs very much from that of the other inteſtines. The external membrane or peritoneum is only ſpread before it; while behind it is ſupported by a broad ſtratum of the cellular ſubſtance, replete with fat and many conglobate glandules, connecting it all the way to the os ſacrum. The muſcular fibres are much ſtronger and more numerous, eſpecially the longitudinal ones, than in the other inteſtines; being compoſed of the three ligaments, expanded and ſpread firſt over the anterior ſurface, and then over the whole inteſtine; they dilate the inteſtine before the advancing feces, and draw it back after the feces are excluded. The tranſverſe fibres are alſo ſtrong; and the laſt of them are oval, forming a protuberant ring, called the internal

internal *ſphincter*, by which the opening of the anus is cloſed.

The villous coat of the inteſtine has a very rough ſurface, is extremely porous, and full of reticulated polygonal wrinkles, and is furniſhed with ſome peculiar ſinuſes. That part of the inteſtine which is next to the ſkin or outward opening forms a white firm circle like a valve, into which deſcend the longitudinal folds. Between theſe folds are intercepted ſinuſes, hollow upwards, and of a greater depth towards the lower extremity of the inteſtine. The mouths of the large mucous glandules open into theſe cavities; while the margin of the anus itſelf is defended by ſebaceous glandules, leſt it ſhould be excoriated by the hard acrid feces.

Whenever, therefore, the feces are collected within the rectum, in ſuch a quantity as to become troubleſome by their weight, irritation, or acrimony, they excite an uneaſineſs through the adjacent viſcera; and are then, by the force of the diaphragm and abdominal muſcles, preſſed downwards through the inner rim of the pelvis, ſo as to urge upon the contents of the leſs reſiſting bladder and rectum. When the reſiſtance of the anus is thus overcome, the compreſſing forces of the diaphragm abate, and the feces continue to diſcharge from the body, urged only by the periſtaltic motion of the inteſtine. After the feces are expelled, the inteſtine, by its longitudinal fibres, is drawn back or up into the body; after which, the opening of the anus itſelf is cloſely contracted by the two proper ſphincters as at firſt. The feces in men and carnivorous animals are very foetid, almoſt putrid, ſubalkaline, ſoft, and contain much oil intimately mixed with ſalts, which are left both by the aliments, as well as by the bile and other humours of the human body. An acrid and foetid water returns from the feces into the blood; hence coſtiveneſs in fevers is hurtful, putrefaction being increaſed by

by the effuſion of the above-mentioned matter into the body.

§ 13. *Hepar, and Veſicula Fellis.*

Situation, figure, and diviſion of the liver. The liver is a large and ſolid maſs, of a dark red colour, a little inclined to yellow, ſituated immediately under the arch of the diaphragm, partly in the right hypochondrium, which it fills almoſt entirely, and partly in the epigaſtrium, between the appendix enſiformis and ſpina dorſi, and terminating commonly in the left hypochondrium, into which it ſometimes runs a conſiderable way.

The figure of the liver is irregular, it being arched or convex on the upper part, unequally concave on the lower, and very thick on the right and back ſides. Towards the left and anterior ſides, its thickneſs decreaſes very much, and terminates there by a kind of edge; and it is broader from right to left than before backwards.

The liver may be divided into two extremities, one great, the other ſmall; two edges, one anterior, and one poſterior; two ſides, one ſuperior and convex, which is ſmooth, poliſhed, and proportioned to the arch of the diaphragm, and one inferior, concave, and uneven, with ſeveral eminences and depreſſions; of which hereafter.

It may likewiſe be divided into two lateral parts, called *lobes;* one of which is termed the *great* or *right lobe*, the other the *ſmall* or *left lobe*. Theſe two lobes are diſtinguiſhed above by a membranous ligament, and below, very plainly, by a conſiderable ſciſſure, lying in the ſame direction with the ſuperior ligament.

The eminences on the concave ſide of the liver belong to the great lobe. The principal eminence is a ſort of triangu-

lar or pyramidal apophyſis, ſituated backward near the great ſciſſure which diſtinguiſhes the two lobes.

This triangular eminence is termed ſimply the *ſmall lobe of the liver*, or *lobulous Spigelii*, though it was known to ſeveral anatomiſts long before his time. One of its angles advances a conſiderable way toward the middle of the lower ſide of the great lobe, and is loſt there. This angle we call the *root* of the lobulus. Toward the foreſide there is another eminence leſs prominent, but broader; and to this eminence, and the former, the antients gave the general name of *portae*.

The depreſſions on the concave or lower ſide of the liver, which deſerve our attention, are four in number. The firſt is the ſciſſure that ſeparates the two lobes which runs acroſs the concave ſide, from the eminences already mentioned, to the anterior edge, where it terminates by a notch of different depths in different ſubjects. This is termed the *great ſciſſure* of the liver; and, in ſome ſubjects, part of it is an entire tube. The ſecond depreſſion is ſituated tranſverſely between the two eminences of the great lobe, and filled by the ſinus of the *vena portae*, ſo called by the antients, becauſe it lies between the eminences of the ſame name. The third depreſſion is backward, between the great lobe and lobulus Spigelii, and the vena cava paſſes through it. The fourth is a kind of ſulcus, between the lobulus and ſmall lobe of the liver, which, in the foetus, ſerved to receive a venal canal loſt in adults, in whom it appears only as a kind of ligament. This ſulcus is in ſome meaſure a continuation of the great ſciſſure, and joins the vena cava by an acute angle.

Beſides theſe four depreſſions, there is one on the fore part of the great lobe, in which the veſicula fellis is lodged; and it ſometimes runs as far as the edge, where it forms a ſmall notch. We may likewiſe reckon among theſe depreſſions a ſmall ſuperficial cavity in the poſterior and lateral part of the lower ſide of the great lobe, by which it reſts on the right kidney;

kidney; and likewiſe a ſuperficial cavity in the left lobe, where it runs over the ſtomach.

Laſtly, on the poſterior edge of the liver, there is a great ſinus common to both lobes, which gives paſſage to the ſpina dorſi and oeſophagus, near the place where the vena cava deſcends; and we ſometimes meet with ſciſſures on both ſides of the liver, which are not ordinary.

Ligaments of the liver. The convex ſide of the liver is commonly connected to the diaphragm, by three ligaments, which are only continuations of the membranous lamina of the peritonaeum. One lies near the edge of the extremity of each lobe, and one in the middle; and they are accordingly termed the *right*, *middle*, and *left ligaments*. There is a cellular ſubſtance in the duplicature of each, in which the blood-veſſels and lymphatics run, and which ſends off a kind of lamina into the ſubſtance of the liver.

The right ligament ſometimes connects the great lobe to the cartilages of the falſe ribs; and the left ligament, or that of the ſmall lobe, is often double, and advances toward the middle ligament. This middle ligament begins below in the great ſciſſure of the liver, near the eminences called *portae*; and from thence paſſes through the anterior notch, and over the convex ſide of the liver, at the union of the two lobes, and is fixed obliquely in the diaphragm.

It is likewiſe fixed along the upper and inner part of the vagina of the right muſculus rectus of the abdomen, in ſuch an oblique manner, as to be nearer the linea alba below than above.

Beſides theſe ligaments, the great lobe of the liver is likewiſe connected to the right ala of the tendinous portion of the diaphragm, not by a ligament, but by a broad and immediate adheſion, without the intervention of the membrane of the peritonaeum, which is only folded quite round this adheſion,

adhesion, to form the external membrane of all the rest of the body of the liver.

This broad adhesion is commonly, though improperly, called *ligamentum coronarium :* But, in the first place, it is not a ligament, as has been already observed; and, secondly, it is not circular, but oval, and very oblong.

It is not on the upper part of the convex side of the liver, but along the posterior part of the great lobe; the broad extremity of the adhesion lying nearer the notch, and the pointed extremity towards the right hypochondrium.

The middle ligament, called improperly *ligamentum hepatis suspensorium*, contains, in its duplicature, a thick white rope, like a round ligament, which was the umbilical vein in the foetus. Thus the lower part represents a falx; the convex edge of which is sharp, and the other rounded.

All these ligaments serve to keep the liver in its proper situation, and to hinder it from inclining too much towards either side: But we must not imagine that any of them serve to suspend it; because it is sufficiently supported by the stomach and intestines, especially when they are filled.

When the stomach is empty, or when we fast longer than ordinary, it is a common expression to say the stomach pinches us. As the liver is not then sustained by the stomach and intestines, it descends by its own weight. and chiefly by means of the middle ligament, pulls the diaphragm along with it. It is in that place, therefore, that we have this uneasy sensation; and not at the superior orifice of the stomach, as is commonly believed.

The right or great lobe of the liver, which lies in the right hypochondrium, rests on the right kidney by a small superficial depression above mentioned; and it likewise covers a portion of the arch of the colon and the pylorus. About two third parts of the small or left lobe lie in the middle of the

the epigaſtrium, and the remaining third part advances over the ſtomach towards the left hypochondrium.

This ſmall lobe is ſituated almoſt horizontally; the great lobe is very much inclined, and its thick extremity runs down almoſt in a perpendicular direction to the right kidney on which it lies, in the manner already ſaid. This obſervation is of uſe to diſtinguiſh the different parts of the liver in wounds and chirurgical operations.

It may likewiſe ſerve to direct us in examining a liver taken out of the body; the ſituation which may be otherwiſe very eaſily miſtaken, eſpecially that of the parts of the concave ſide. The paſſage of the vena cava, between the body of the great lobe and the lobulus Spigelii, may likewiſe ſerve for a rule in placing a detached liver in its true ſituation.

Structure of the liver. The liver is compoſed of ſeveral kinds of veſſels; the ramifications of which are multiplied in an aſtoniſhing manner, and form, by the intertexture of their capillary extremities, an innumerable collection of ſmall pulpy friable corpuſcles, which are looked upon to be ſo many organs deſigned to ſeparate from the maſs of blood a particular fluid, termed the *bile*.

The greateſt part of theſe veſſels, from one end to the other, is included in a membranous vagina, called *capſula venae portae*, or *capſula Gliſſoni*, from an Engliſh author who firſt deſcribed it particularly, about the middle of the laſt century. This vagina is commonly conſidered as a continuation of the membrane which covers the liver, and which penetrates this ſubſtance along with the blood-veſſels; but Sabatier is of opinion that it is a continuation of the cellular membrane which covers the vena portae ventralis.

The veſſel which carries the blood to the liver is called *vena portae*, for the reaſon already given. In the deſcription of the veins, we obſerved that the vena portae might

be

be conſidered as two large veins, the trunks of which are joined endwiſe, and ſend out branches and ramifications in oppoſite directions to each other; that one of theſe veins is ramified in the liver, the other lying without the liver, and ſending its branches and ramifications to the viſcera of the abdomen; and, laſtly, that the firſt of theſe large veins may be termed *vena portae hepatica*, the other *vena portae ventralis*.

Vena portae hepatica. The particular trunk of the vena portae hepatica is ſituated tranſverſely between the broad anterior eminence of the great lobe of the liver and the root of the lobulus in a particular ſciſſure, and forms what is called the *ſinus of the vena portae*. From this ſinus five principal branches go out, which are afterwards divided into millions of ramifications through the whole ſubſtance of the liver.

At this place the vena portae lays down the common office of a vein, and becomes a kind of artery as it enters, and is again ramified in the liver. The extremities of all theſe ramifications of the trunk of the vena portae hepatica end in the pulpy friable corpuſcles of the liver.

Pori bilarii et ductus hepaticus. It is in theſe corpuſcles that the bile is ſecreted, and it is immediately collected in the ſame number of extremities of another kind of veſſels, which unite, by numerous ramifications, into one common trunk. Theſe ramifications are termed *pori bilarii*, and the trunk *ductus hepaticus*; and the ramifications of theſe two kind of veſſels are inveſted together by the capſula of the vena portae.

Hepatic veins. The blood deprived of this bilious fluid is reconveyed to the heart by a great number of venal ramifications, which afterwards unite into two or three principal branches, beſides others that are leſs conſiderable, that terminate in the vena cava, and are all called by the name of *vena hepatica*.

The capillary extremities of the ramifications of the vena hepatica, join thoſe of the vena portae, and accompany them through

through the liver; and yet the great branches of both veins interſect each other in ſeveral places.

When we cut the liver in ſlices, it is eaſy to diſtinguiſh in each ſlice the ramifications of the vena hepatica from thoſe of the vena portae; the firſt being thinneſt and largeſt, and adhering cloſeſt to the ſubſtance of the liver; whereas thoſe of the vena portae, which are inveſted by the cellular capſula, appear to be a little ruffled when empty; becauſe the cellular capſula ſubſides when it is cut, but the other veins remain uniformly open, their ſides adhering to the ſubſtance of the liver; beſides, they are accompanied by the branches of the hepatic artery and biliary ducts which do not follow thoſe of the vena hepatica: And Sabatier obſerves, that the direction of the branches of the vena hepatica is perpendicular to that of the vena portae.

Hepatic artery and nerves. The liver receives from the arteria caeliaca a particular branch, termed *arteria hepatica*; which being very ſmall when compared with the bulk of that viſcus, ſeem deſigned only for its nouriſhment, and not for the ſecretion of the bile. The plexus hepaticus, formed by the nervi ſympathetici maximi et medii, furniſhes a great number of nerves to the ſubſtance of the liver. The ramifications of the artery and nervous plexus are included in the cellular capſula, together with thoſe of the vena portae and pori biliarii.

The pulſation of this artery has been by ſome anatomiſts taken for that of the capſula, which they ſuppoſed to be muſcular; and by this they have endeavoured to explain the arterial function of the vena portae: But they have not conſidered that the blood in this vein does not require to be pumped forward; becauſe ſo ſwift a motion would have been prejudicial to the ſecretion of the fine oil of the bile, for which a ſlow and almoſt inſenſible motion is neceſſary. Cowper and Santorinus were the firſt who doubted of the muſcular

lar nature of the capſula, and they have been followed in this opinion by modern anatomiſts.

The liver is covered exteriorly by a particular membrane or coat, which is a continuation of the peritonaeum. A membranous or filamentary ſubſtance likewiſe runs through this whole viſcus, and connects the ramifications and extremities of all its veſſels to each other. This ſubſtance ſeems to be a complicated production of the capſula of the vena portae, and of the external membrane of the liver.

The outer ſurface of this coat is very ſmooth, but its inner ſurface is uneven, conſiſting of a great number of thin membranous laminae; between which we obſerve very diſtinctly, numerous lymphatic veſſels, on both the convex and concave ſides of the liver; but it is more difficult to trace thoſe which accompany the filamentary ſubſtance through that viſcus. Some of the lymphatic veſſels, from the ſubſtance and concave ſurface of the liver, run in the capſule of Gliſſon; and after paſſing through conglobate glands ſituated there, they end at laſt in the receptaculum chyli, or into ſome of the large lacteals; others, upon the convex ſurface of the liver, run to the ligamentum ſuſpenſorium, from which they pierce the diaphragm in company with the vena cava, to end in the thoracic duct.

We have already obſerved, that the ſubſtance of the liver is chiefly made up of an infinite number of pulpy friable corpuſcles; each of which is bounded, and in a manner ſurrounded by a particular expanſion of the capſula Gliſſoni; and all theſe expanſions are connected by common ſepta, in ſome meaſure reſembling a bee-hive.

Theſe corpuſcles have ſeveral angles, eſpecially in the inner ſurface of the liver; but near the ſurface they are raiſed in the form of ſmall tubercles. Their pulpy texture appears like radiated villi, a ſmall void ſpace being left in the middle of each.

If

If we blow through a pipe into the vena portae, vena cava, arteria hepatica, or trunk of the pori bilarii, but eſpecially through the two veins, we obſerve the liver to ſwell, and the corpuſcles near the ſurface are raiſed, and become more ſenſible. If we blow with much force, we burſt theſe corpuſcles; and the air, getting between them and the external membrane, raiſes it from the ſubſtance of the liver in bliſters.

Ductus cholidochus. The ductus hepaticus, or trunk of the pori bilarii, having run a little way, joins another canal, called *ductus cyſticus* or *veſicularis*; becauſe it comes from the veſicula fellis, as we ſhall ſee in the deſcription of that organ. Theſe two united ducts form a common trunk, named *ductus cholidochus*; becauſe it conveys the bile. This duct having reached the incurvation of the duodenum, inſinuates itſelf through the coats of that inteſtine, and opens into its cavity not by a round papilla, but by an oblong orifice rounded at the upper part, and contracted at the lower like the ſpout of an ewer, or like a common tooth-picker.

The edges of this orifice are raiſed, broad, and plaited, as we may ſee by making this portion of the duodenum ſwim in clear water. At the entry of this orifice we ſee another ſmall opening diſtinct from it, which is the orifice of the ductus pancreaticus; of which hereafter. Gliſſon was of opinion, that the extremity of the ductus cholidochus was furniſhed with a ſphincter of muſcular fibres, which was capable of ſhutting the orifice, and of preventing the contents of the duodenum from entering it; but no ſuch duct has been found by others, and the obliquity of the paſſage anſwers the ſame purpoſe.

Veſicula fellis. The gall-bladder is a kind of ſmall bag, ſhaped like a pear, that is, narrow at one end, and wide at the other. The wide extremity is termed the *fundus* or *bottom*, the narrow extremity the *neck*, and the middle portion the *body*. About one third of the body of the veſicula lies

in a depreſſion on the concave ſide of the liver, from the trunk or ſinus of the vena portae, where the neck is ſituated, to the anterior edge of the great lobe, a little toward the right ſide, where the bottom is placed; and in ſome ſubjects it advances beyond the edge, ſo as to oppoſe itſelf to the muſcles of the abdomen, under the edges of the falſe ribs.

Therefore when we ſtand, the veſicula fellis lies in a plane inclined a little from behind forward. When we lie upon the back, it is almoſt inverted. When we lie on the right ſide, the bottom is turned downward, and it is turned upward when we lie on the left ſide; and theſe ſituations vary according to the different degrees of each poſture.

The gall-bladder is compoſed of ſeveral coats, the outermoſt of which is a continuation of that which inveſts the liver, and conſequently of the peritoneum.

The under ſide of the gall-bladder touches the colon at the beginning of the duodenum, and ſometimes at the pylorus.

The ſecond coat is ſaid by ſome to be fleſhy, and made up of two ſtrata, one longitudinal, the other tranſverſe, like that of the ſtomach or inteſtines; but, excepting in ſome very robuſt ſubjects, there are ſcarcely any muſcular fibres to be ſeen.

A whitiſh ſtratum is looked upon as the third coat of the gall-bladder, anſwering to the tunica nervoſa of the inteſtines.

The innermoſt, or fourth coat, has on the inſide a great number of reticular folds, filled with ſmall lacunae, like perforated papillae, eſpecially near the neck of the veſicula, where theſe folds are longitudinal, and afterwards form a kind of ſmall pylorus, with plaits of the ſame nature with thoſe in the great one. Theſe lacunae are looked upon to be glands. Sabatier admits only of the firſt and the laſt of theſe coats, and conſiders the intermediate ſubſtance as being merely cellular and vaſcular.

That

That ſide of the body of the veſicula which lies next the liver, is connected to that viſcus by a vaſt number of filaments, which run a great way into the ſubſtance of the liver. Among theſe fibres, in ſome animals, ducts have been obſerved a long time ago. They are moſt numerous near the neck of the veſicula, and they are named *ductus cyſto-hepatici*, or *hepatico-cyſtici*; but no ſuch ducts can be demonſtrated in the human body.

The neck of the veſicula is formed by the contraction of the ſmall extremity; and this neck, bending afterwards in a particular manner, produces a narrow canal, named *ductus cyſticus*. This incurvation repreſents, in ſome meaſure, the head of a bird, of which the cyſtic duct, by the gradual diminution of its diameter, expreſſes the beak. This cannot be ſeen when the liver is *extra ſitum*; and even *in ſitu* it is but very imperfectly ſeen, when, in order to view the concave ſide, the liver is raiſed and thruſt too much againſt the diaphragm; for, by thus inverting the liver, the curvature is diſordered, and we ſee two in the place of one.

To ſee this curvature in its true natural ſituation, the liver is to be raiſed but very little, and the duodenum left untouched; then we muſt ſtoop and look under the liver without diſordering any thing. This incurvation may be of uſe to hinder too precipitate a diſcharge of the bile contained in the veſicula, which ſome ſituations of the body might occaſion.

The neck of the veſicula is nearly of the ſame ſtructure with the other parts. It has on the inſide ſeveral reticular rugae and ſome folds, which appear like fragments of valvulae conniventes, ſituated very near each other, from the neck to the contraction of the cyſtic duct. The firſt of theſe folds is broad and large, and almoſt circular; the next is more oblique and ſmaller in ſize, and the reſt diminiſh in the ſame manner. Taken all together, they form a kind of ſpiral

flight,

flight, which may be ſeen through the neck on the outſide, where it ſometimes appears like a ſcrew, eſpecially when the neck is filled with any fluid. This obſervation is owing to M. Heiſter.

By ſlitting the neck and duct, we ſee all theſe folds very diſtinctly, eſpecially when we examine them in clear water. When they are viewed in any other manner, they eaſily deceive us, being miſtaken for true valves, becauſe of their tranſverſe ſituation. They may, however, in ſome meaſure ſupply the place of valves, by hindering the bile from running too faſt into the duodenum, and the contents of the duodenum from entering this duct. The ſtructure of the biliary ducts appear to be entirely membranous, covered externally with a thick cellular ſubſtance, and lined within by a kind of tunica villoſa, which is pierced with numerous holes, that make it appear like a ſieve. Through theſe a mucous humour flows, to ſave the ducts from the impreſſion of the bile. And the internal ſurface of all theſe biliary ducts, that is, of the ductus hepaticus, cyſticus, and cholidochus being examined through a microſcope in clear water, appears to be nearly of the ſame ſtructure through their whole extent.

The cyſtic and hepatic ducts do not, in their ordinary and natural ſituation, repreſent the capital Greek Y, where they form the ductus cholidochus. After the incurvation of the neck of the veſicula, theſe two ducts run very near each other, and they appear to be ſeparated only by raiſing up the liver to view them. The ſame diſorder happens in an inverted liver extra ſitum; for then the body of the liver ſubſides and is flattened, and thereby ſeparates the ducts; whereas, in its true ſituation, it is very much incurvated, and the ducts very near each other.

The ductus cholidochus appears rather to be a continuation of the ductus cyſticus, than the common trunk of that and

and of the ductus hepaticus; for this laſt duct runs for ſome ſpace within the ſides of the former, before it opens into the cavity, much in the ſame manner as the ductus cholidochus paſſes into the duodenum. Winſlow has obſerved, at the opening of the hepatic into the cyſtic duct, a ſmall looſe valvular membrane, which may hinder the bile from returning out of the ductus cholidochus into the hepaticus. But later anatomiſts deſcribe only a ſharp angle at the meeting of the cyſtic and hepatic ducts, ſimilar to the bifurcation of the arteries or veins.

The bile, which paſſes through the ductus hepaticus into the cholidochus, may be called *hepatic;* and that which is collected in the veſicula fellis, may be termed *cyſtic.* The hepatic bile flows continually through the ductus cholidochus into the duodenum; whereas the cyſtic bile flows only by reaſon of plenitude, or by compreſſion.

Remarks on the veſſels, &c. of the liver. The trunk of the vena portae ventralis terminates between the lobulus and the oppoſite part of the great lobe; and there joins the trunk of the vena portae hepatica in the tranſverſe ſinus of the liver, between the right extremity and the middle of that ſinus.

The umbilical ligament, and conſequently the umbilical vein in the foetus, joins the trunk of the vena portae hepatica toward the left extremity of the tranſverſe ſinus of the liver. The canalis venoſus in man is not exactly oppoſite the vena umbilicalis, but a little to the right ſide; and therefore theſe three veſſels lie in ſuch a direction as to form two oppoſite angles, reſembling thoſe of the handle of a wheel or of a ſpit.

In the foetus, therefore, the blood which comes from the umbilical vein does not run directly through that contained in the vena porta hepatica in the ſinus, and from thence into the canalis venoſus; but is obliged to turn from left to right, and ſo to mix with the blood in the vena portae, before it enters

enters that canal which opens into the trunk of one of the great hepatic veins of the vena cava near the diaphragm.

The hepatic vena portae gives off commonly five large branches into the liver, viz. three from its right extremity into the great lobe, and two from its left extremity into the ſmall lobe; and from the interſtice between theſe, a ſmall branch goes directly to the middle of the convex ſide of the liver.

The hepatic veins are commonly two or three large branches, which go into the trunk of the vena cava by one common opening, eſpecially two of them. In the ſubſtance of the liver, they interſect the branches of the hepatic vena portae, and are ramified in all directions, in the manner already explained. The inferior portion of the opening of theſe veins into the vena cava, forms a kind of ſemilunar valve.

Below theſe hepatic veins, the vena cava inferior, in its paſſage by the liver, receives ſeveral other ſmall hepatic veins, which ſeem to have the ſame relation to the hepatic artery, as the great veins to the vena portae.

The paſſage of the vena cava is through the right portion of the poſterior ſinus of the liver, and conſequently on the ſide of the great lobe, which is hollowed at this place ſufficiently to give paſſage to the vein, of which it ſurrounds about three-fourths, ſometimes more, and ſometimes the whole.

This paſſage anſwers to the interſtice between the lobulus and the reſt of the great lobe; and its direction is, in the natural ſtate, from below upwards, and a little from left to right: But, when the liver is viewed extra ſitum, and inverted, it appears very oblique; but ſtill it ſerves as a guide to beginners, who are very apt to be miſtaken in examining an inverted liver.

The trunk of the great vena portae, the hepatic arteries, the ductus hepaticus, or trunk of the pori biliarii, and the nerves

nerves of the plexus hepaticus, form altogether a large bundle before they enter the liver. The trunk of the hepatic vena portae is in the middle of this bundle; the hepatic arteries lie on the right and left ſides of this trunk; the nerves ſurround it on all ſides, and they communicate with the plexus meſentericus ſuperior.

Afterwards, the firſt branches of the arteries, nerves, and pori biliarii, leave the trunk of the great vein, and join in the ſame manner the trunk of the ſmall or hepatic vena portae, and its ramifications in the capſula Gliſſoni explained above.

All theſe branches of the vena portae, and of the arteries, nerves, and pori biliarii, accompany each other by ramifications through the whole ſubſtance of the liver, forming every where ſmall faſciculi, in the ſame manner as the large bundles were formed by their trunks. Each ramus of the vena portae, artery, nerve, and porus biliarus, has a proper vagina, and all the four have a common vagina diſtinguiſhed from the former cellular ſepta, which are only continuations of the vaginae of both kinds.

The convex ſide of the common cellular vagina is connected quite round to the ſubſtance of the liver by numerous filaments which ariſe from it, and which form the cellular ſubſtance found between the glandular corpuſcles. The concave ſide produces the cellular ſepta above mentioned.

In this common vagina, the veſſels, ducts, and nerves, are diſpoſed in ſuch a manner, as that the rami of the vena portae chiefly fill the cavity of it, and lie in a lateral ſituation. The arterial ramus, and porus biliarus lie together on the ſide of the vein, and the nerve is divided into ſeveral filaments, which run in between the veſſels and ducts, and chiefly accompany the artery and porous biliarius; the vena portae having by much the feweſt.

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The uſes of the liver ſhall be explained after the deſcription of the pancreas, ſpleen, and omentum, all theſe viſcera having a great relation to the liver.

§ 14. *Pancreas.*

Figure, diviſion, and ſituation of the pancreas. The pancreas is a long flat gland, of that kind which anatomiſts call *conglomerate*, ſituated under the ſtomach, between the liver and the ſpleen. Its figure reſembles that of a dog's tongue; and it is divided into two ſides, one ſuperior, the other inferior; two edges, one anterior, the other poſterior; and two extremities, one large, which repreſents the baſis of a tongue, and one ſmall, and a little rounded, like the point of a tongue.

The pancreas is ſituated tranſverſely under the ſtomach, in the duplicature of the poſterior portion of the meſocolon. The large extremity is connected to the firſt incurvation of the duodenum, and from thence it paſſes before the reſt of that inteſtine all the way to its laſt incurvation; ſo that a great part of the duodenum lies between the pancreas and the vertebrae of the back. The ſmall extremity is fixed to the omentum, near the ſpleen.

Structure of the pancreas. The pancreas is compoſed of a great number of ſoft glandular moleculae, combined in ſuch a manner as to exhibit the appearance of one uniform maſs on the outſide, the ſurface of which is rendered uneven only by numerous ſmall convexities, more or leſs flatted. When theſe moleculae are ſeparated a little from each other, we find, along the middle of the breadth of the pancreas, a particular duct, in which ſeveral ſmaller ducts terminate laterally on each ſide, like ſmall rami in a ſtem.

This canal, named *ductus pancreaticus*, or *ductus Virſungi*, from the diſcoverer of it in the human body, is very thin, white,

white, and almoſt tranſparent, and the extremity of the trunk opens commonly into the extremity of the ductus cholidochus. From thence it diminiſhes gradually, and terminates in a point next the ſpleen. The ſmall lateral branches are likewiſe large near the trunk, and very ſmall toward the edges of the pancreas, all of them lying in the ſame plane like the branches of the common filix or fern.

The pancreatic duct is ſometimes double in man, one part lying above the other. It is not always of an equal length, and ſometimes runs in a winding courſe, but always in the ſame plane; and it is nearer the lower than the upper ſide of the pancreas. It pierces the coat of the duodenum, and opens into the ductus cholidochus, commonly a little above the prominent point of the orifice of that canal; and ſometimes it opens immediately into the duodenum.

The ſmall pancreas. In man, Winſlow obſerved, that, where the great extremity of the pancreas is connected to the curvature of the duodenum, it ſends down an elongation, which adheres very cloſely to the following portion of the inteſtine; and, upon a careful examination, he found a particular pancreatic duct ramified like the large one, which ran toward, and interſected this great duct, into the extremity of which it opened after having perforated the duodenum. This portion he termed *pancreas minus*. It ſometimes opens ſeparately into the duodenum, in which we likewiſe obſerve ſeveral ſmall holes round the ductus cholidochus, which anſwer to the pancreas.

Blood-veſſels and nerves of the pancreas. The arteries of the pancreas come from the pylorica, duodenalis, and chiefly from the ſplenica, which adheres very cloſely to the whole lower ſide of the pancreas near the poſterior edge, and it ſends off in its paſſage a great many rami named *arteriae pancreaticae*, which go off from each ſide, more or leſs tranſ-

verſely. It receives alſo ſome ſmall ramifications from the gaſtrica major and meſenterica ſuperior.

The pancreatic veins are rami of the ſplenica, one of the principal branches of the vena portae major or ventralis. This vena ſplenica runs likewiſe along the lower ſide of the pancreas near the edge, in a ſhallow depreſſion formed in the ſubſtance of the gland. Theſe veins anſwer to the arteries of the ſame name; and there are likewiſe other ſmall veins correſponding to the ſmall arteries, which are productions of the great meferaica, &c.

The nerves of the pancreas come partly from the plexus hepaticus, partly from the plexus ſplenicus, and partly from the plexus meſentericus ſuperior; and it likewiſe receives ſome from the flat ganglion or plexiform intertexture, mentioned in the deſcription of the nerves by the name of the *tranſverſe rope*.

The pancreatic duct is not only double in ſome ſubjects, as has been ſaid, but the collateral branches have communications in form of iſlands in ſeveral places within the body of the pancreas.

The pancreatic juice, which is watery, inſipid, thin, neither acid nor alkaline, is poured into the ſame place into which the bile diſcharges itſelf. The quantity of juice ſecreted by the pancreas is uncertain; but it muſt be very conſiderable, if we compare the bulk or weight of it with that of the ſalival glands; than which it is three times larger, and ſeated in a warmer place. It is expelled by the force of the circulating blood, with an alternate preſſure from the incumbent and ſurrounding viſcera; as the liver, ſtomach, ſpleen, meſenteric and ſplenic arteries, and the aorta. The great uſefulneſs of this gland may appear from its being found, not only in man, but almoſt in all animals: Nor is its uſe the leſs from the experiment which ſhews that a great part of it may be cut out from a robuſt animal without occaſioning death; be-

cauſe,

cauſe, in the experiment, a part of the pancreas muſt be left with the duodenum.

The pancreatic juice ſeems principally of uſe to dilute the viſcid cyſtic juice, to mitigate its acrimony, and mix it with the food. Hence it is poured into a place remote from the cyſtic duct as often as there is no cyſtis. Like the reſt of the inteſtinal humours, this juice dilutes the maſs of aliments, reſolves them, and does every other office of the ſaliva.

§ 15. *Lien.*

Situation, diviſion, and figure of the ſpleen. THE ſpleen is a bluiſh maſs, ſomething inclined to red, and of a long oval figure, being about ſeven or eight fingers breadth in length, and four or five in breadth. It is of a ſoftiſh ſubſtance, and is ſituated in the left hypochondrium, between the great extremity of the ſtomach and the neighbouring falſe ribs, under the edge of the diaphragm, and above the left kidney.

It may be naturally divided into ſides, edges, and extremities. It has two ſides, one external and gently convex, and one internal, which is irregularly concave; two extremities, one poſterior, which is large, and one anterior, which is ſmaller, and more depreſſed; two edges, one ſuperior, and one inferior, on both which there are, in ſome ſubjects, ſeveral inequalities.

The inner or concave ſide is divided by a longitudinal groove or ſciſſure, into two planes or half ſides, one upper, the other lower; and by this groove, the veſſels and nerves enter in human ſubjects. The ſuperior half ſide is broader and more concave than the inferior, being proportioned to the convexity of the great extremity of the ſtomach. The inferior half ſide lies backward on the left kidney, and forward on the colon; and ſometimes this ſide of the ſpleen appears to have two ſuperficial cavities, one anſwering to the convexity

convexity of the ſtomach, the other to that of the colon. The convex ſide of the ſpleen is turned to the left ribs.

It is connected to the ſtomach by the veſſels called *vaſa brevia*; to the extremity of the pancreas, by ramifications of the ſplenic artery and veins; and to the omentum, by ramifications which the ſame artery and vein ſend to the ſpleen, and which run in the longitudinal groove.

It is connected to the edge of the diaphragm by a particular membranous ligament of different breadths in different ſubjects, fixed in its convex ſide, ſometimes near the upper edge, ſometimes near the lower. This ligament is ſituated tranſverſely with reſpect to the whole body, and longitudinally with reſpect to the ſize of the ſpleen. In ſome ſubjects, it is connected by other ligaments to the ſtomach and colon; but in all this there are conſiderable varieties.

The figure of the ſpleen is not always regular, and is as various as the ſize. Sometimes it has conſiderable ſciſſures both in the ſides and edges, and ſometimes it has appendices. I have ſometimes found a kind of ſmall diſtinct ſpleens, more or leſs round, and connected ſeparately to the omentum, at ſome diſtance from the anterior extremity of the ordinary ſpleen.

Structure of the ſpleen. The ſtructure of the ſpleen is not eaſy to be unfolded in man; and it is very different from that of the ſpleens of brutes.

Its coverings adhere to it ſo cloſely in man, that it is difficult to diſtinguiſh the common from the proper coat; whereas in ſome brutes, ſuch as oxen, ſheep, &c. nothing is more eaſy; for in ſuch animals we find two coats ſeparated by a cellular ſubſtance. This covering ſeems to be no otherwiſe a continuation of the peritonæum than by the intervention of the omentum and meſocolon; and even in man the two coats may be diſtinguiſhed, where the veſſels enter by the longitudinal ſciſſure.

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In man, the ſubſtance of the ſpleen is almoſt wholly vaſcular, that is, compoſed of the ramifications of all kinds of veſſels. In oxen, the ſubſtance of the ſpleen is chiefly reticular, and in ſheep it is cellular. In oxen and ſheep, there are no venal ramifications; but only open ſinuſes diſpoſed like branches, except a ſmall portion of a venal trunk perforated on all ſides, at the extremity of the ſpleen.

Structure and uſe of the ſpleen. The ſpleen is one of thoſe viſcera which ſend their blood to the liver. The ſituation of it varies with that of the ſtomach. When the ſtomach is empty, the ſpleen is raiſed perpendicularly, ſo as to place its extremities right up and down; but when the ſtomach is full, the middle curve or arch of the ſpleen ariſes upward and forward; and at the ſame time obliges it to change its ſituation, ſo as to lie almoſt tranſverſely with its lower end forward, and its upper end backward. Being of a very ſoft and looſe texture, it grows larger by diſtenſion when the ſtomach is empty, and becomes leſs again when it is preſſed by the full ſtomach againſt the ribs. Hence the ſpleen is found large in thoſe who die of lingering diſeaſes; but in thoſe who die ſuddenly, and in full health, it is ſmall. The ſpleen deſcends with the diaphragm in inſpiration, and aſcends again in expiration; and it often varies in its ſituation with the colon. Frequently there is a ſecond or leſs ſpleen placed upon the former.

The blood veſſels of the ſpleen are large, in proportion to its weight. The arterial trunk comes from the coeliac; the upper branch of which, proceeding in a ſerpentine courſe above and behind the pancreas, to which it gives branches, as well as to the meſocolon, ſtomach, and omentum, is at length incurvated in the direction of the ſulcus or notch of the ſpleen, which it perforates by ſeveral diſtinct branches, ſuſtained by the right extremity of the omentum gaſtrocolicum. The denſity of this artery is greater than that of the aorta. The

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ſplenic vein, which accompanies the artery, is conſiderably ſofter than any other vein of the body; it forms the principal left branch of the vena portae. Beſides theſe, the ſpleen receives ſmall arteries from the great coronary deſcending behind the pancreas, and ſometimes from the internal haemorrhoidal. The vaſa brevia of the ſpleen and ſtomach we have mentioned elſewhere; and its ligaments and membranes receive ſmall arterial twigs from the lumbar arteries, phrenics, intercoſtals, and thoſe of the renal capſules. The veins in the ſpleen, and thoſe which join it to the ſtomach, communicate with the phrenics, and with the veins of the renal capſules.

The *lymphatic veſſels* of the ſpleen ariſe in the duplicature of the ſplenic coat or membrane, and from thence proceed on to the receptacles of the chyle. They are very evident in calves; but in men they are rendered conſpicuous by blowing air under the membrane, by maceration, or water injected into the arteries.

The *nerves* of the ſpleen are very ſmall; from whence it is capable of but little pain, and is very rarely inflamed. They ariſe from a particular plexus, compoſed of the poſterior branches of the eighth pair at the ſtomach, and of certain branches from the large gangliform plexus, which produces the ſplenic trunk of the intercoſtal nerve, from whence the branches ſurround the artery into the ſpleen.

The fabric of the ſpleen appears to be much more ſimple than has been commonly believed; for it is compoſed, both in us and calves, altogether of arteries and veins. The arteries are ſubdivided into few large branches, but into very numerous ſmall twigs, which are difficult to fill with injections: Theſe twigs terminate in circles, which afford the fluid a ready paſſage into the concomitant veins. Theſe circles, with their parallel branches, form roundiſh bruſh-like pencils, that have been miſtaken for glands; but the injection,

tion, rightly managed, never eſcapes out of the veſſels, nor were any hollow glandules ever obſerved. Every little arterial trunk, with the ſmaller twigs that proceed from t, are each of them ſurrounded, like the ſmall veſſels of all the other viſcera, by a very fine cellular ſubſtance, but rather ſofter than is uſual in other parts. The whole of the ſpleen is outwardly ſurrounded by a ſingle tender membrane, continued from the peritonaeum, and joined to the fleſhy part of the ſpleen by a thick cellular texture.

The ſpleen contains more blood than the other viſcera; for it has no muſcles, fat, air-veſſels, or excretory ducts, interpoſed between its blood-veſſels. We learn alſo from obſervation, that the blood of this part ſcarcely ever congeals. It is of a dark brown colour, and by its thinneſs, colour, and the great quantity of water it contains, it may be compared to the blood of a foetus. It abounds with water and a volatile ſalt, but has little oil.

The want of an excretory duct to the ſpleen has occaſioned the uſe of it to be doubtful and controverted. Its fabric ſeems to lead us to the following, although, perhaps, not all the uſes of the ſpleen. A great quantity of blood is carried to the ſpleen, and with a ſlow motion, from the ſerpentine courſe and denſity of the artery: When the ſtomach is empty, the blood comes into the ſpleen in a greater quantity than at any other time: The ſpleen being then alſo leſs preſſed, the blood ſeems to ſtagnate in it; and this ſtagnation is the more probable, both on account of the large capacity of the branches, in compariſon with the trunks of the artery, and on account of the difficult circulation from the ſpleen through the liver. Hence the frequent ſchirrhoſities of the ſpleen, and hence the immenſe quantity of blood with which the ſpleen is diſtended. The blood in the ſpleen, which viſcus is warmed and fomented by the adjacent colon containing putrid feces, is reſolved, attenuated, and aſſumes a putreſcent

trefcent ſtate, as is evident from its colour and conſiſtence. But the greater fluidity of the blood may proceed not only from this diſſolution, but becauſe all its watery juices that enter by the artery return alſo again by the vein; for there are no ſecretory ducts in the ſpleen.

Moreover when the ſtomach is full of food or flatus, the ſpleen is thereby compreſſed into a narrower compaſs, againſt the ribs and ſuperincumbent diaphragm; by which means the blood, that before was ſcarce able to creep along through the ſplenic veins, being now preſſed out more plentifully, returns with a greater celerity towards the liver, where it mixes in the trunk of the porta with the ſluggiſh blood, replete with oily particles from the omentum and meſentery, which it dilutes, and renders leſs apt to ſtagnate or congeal: It conduces alſo to promote a larger ſecretion of bile, at a time when that fluid is moſt wanted, viz. during digeſtion. The ſpleen, therefore, ſeems to prepare the blood for ſupplying a ſort of watery juice, (probably of a ſubalkaline nature, and rendered ſomewhat ſharp by the remora of the blood) to the bile.

Is the ſpleen of a cellular fabric? Is the blood poured out into thoſe cells ſo as to ſtagnate? or is the blood diluted with ſome juice ſecreted by peculiar glands? We ſee nothing of this demonſtrable by anatomy; nor does the liquor or wax injected ever extravaſate into the cellular ſubſtance, unleſs urged with much greater violence than nature ever uſes or intended. As to the old queſtion, Whether the ſpleen perpares an acid to whet or ſharpen the ſtomach; that opinion has been long diſcarded, as repugnant to the nature of all the animal juices. If it be aſked, Whether the ſpleen be not an uſeleſs maſs, as it might ſeem to be from the little damage an animal ſuſtains after it has been cut out? we anſwer, That a robuſt animal, ſuffering but little injury from the loſs of a part, does not prove it to be uſeleſs; but there are examples, after ſuch an experiment has been made, that the li-

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ver becomes ſwelled, diſeaſed, and prepares a leſs quantity of bile, and of a darker brown colour; while the animal is perpetually troubled with flatulencies, gripes, or indigeſtion; all which are to be aſcribed to the vitiated nature of the bile, an obſtruction of the liver, and an imperfect or weak digeſtion; at the ſame time they are confirmed by repeated experiments.

§ 16. *Omentum and Appendices Epiploicæ.*

Situation, diviſion, and connection of the omentum. The omentum is a large, thin, and fine membranous bag, ſurrounded on all ſides by numerous portions of fat, which accompany and even inveſt the ſame number of arteries and veins adhering cloſely to each other.

The greateſt part of it reſembles a kind of flat purſe, or a ſportſman's empty pouch; and is ſpread more or leſs on all the ſmall inteſtines from the ſtomach to the lower part of the regio umbilicalis. Sometimes it goes down to the lower part of the hypogaſtrium, and ſometimes does not reach beyond the regio epigaſtrica. It is commonly plaited or folded in ſeveral places, eſpecially between the bands of fat.

It is divided into a ſuperior and inferior, an anterior and poſterior, and a right and left portion. The ſuperior portion is in a manner divided into two borders, one of which is fixed along the great curvature or convex ſide of the arch of the colon, and the other along the great curvature of the ſtomach. The commiſſure or union of theſe two borders, on the right ſide, is fixed to the common ligament or adheſion of the duodenum and colon, and to the contiguous parts of theſe two inteſtines. That on the left ſide is fixed to the longitudinal ſciſſure of the ſpleen, to the extremity of the pancreas, and to the convex ſide of the great extremity of the ſtomach. It is likewiſe fixed to the membranous liga-

ment which ſuſtains the ductus cholidochus, and connects it to the vena portae ventralis.

Below theſe adheſions, the other portions, that is, the anterior, poſterior, two lateral and inferior portions, which laſt is the bottom of the ſacculus epiploicus, have commonly no fixed connections, but lie looſe between the fore-ſide of the cavity of the abdomen and the inteſtines. The anterior and poſterior portions are generally called the *laminae* of the omentum; but as that term is ordinarily employed to expreſs the duplicature of ſome compound membrane, it would be more convenient to call them *folia*, *alae*, or ſome ſuch name.

Structure of the omentum. The membrane of the omentum is, through its whole extent, made up of two extremely thin laminae joined by a cellular ſubſtance, the quantity of which is very conſiderable along the blood-veſſels, which it every where accompanies in broad bands proportioned to the branches and ramifications of theſe veſſels. Theſe cellular bands are more or leſs filled with fat, according to the corpulency of the ſubject; and for that reaſon I have called them *bands* or *portions of fat*.

Little omentum. Beſides this large membranous bag, which I name the *great omentum*, there is another much ſmaller, which differs from the large one, not only in ſize, but alſo in figure, ſituation, and connection; and this I name the *little omentum*. This ſmall bag is fixed by its whole circumference, partly to the ſmall curvature of the ſtomach, and partly to the concave ſide of the liver before the ſinus of the vena portae, ſo as to ſurround and contain the prominent portion of the lobulus.

The little omentum is thinner and more tranſparent than the other, and its cavity diminiſhes gradually from the circumference to the bottom, which in ſome ſubjects terminates in ſeveral ſmall cavities or foſſulae more or leſs pointed. Its ſtructure is much the ſame with that of the great omentum, it being compoſed of two laminae, with a mixture of the

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ſame portions of fat, which are conſiderably finer than in the other.

We ſee from this ſituation of the two omenta, that in the ſpace left between the lower ſide of the ſtomach, and upper ſide of the meſocolon, they have a very broad communication with each other; ſo that if either of them contained in its cavity any fluid, that fluid might readily get between the ſtomach and meſocolon, and ſo paſs into the other bag; eſpecially when the ſtomach is empty, and conſequently its ſituation eaſily changed.

Therefore, by means of this interſtice between the ſtomach and meſocolon, the two omenta form one cavity, which opens into the cavity of the abdomen by one common orifice, ſituated near the commiſſure on the right ſide of the great omentum. This orifice is ſemilunar or ſemicircular, and formed by the union of the two membranous ligaments, whereof one connects the beginning of the duodenum and neck of the veſicula fellis to the liver; the other connects the contiguous portion of the colon to the ſame viſcus, and extends to the pancreas. From thence ariſes an incurvated border, which ſurrounds the root of the lobulus, leaving an opening wide enough to admit the end of the finger.

To diſcover this orifice of the omentum, we need only raiſe a little the great lobe of the liver, and find out the root of the lobulus; and apply it to a large pipe wrapped round with cotton, wool, or tow, to hinder the regreſs of the air. Then if we blow gradually, the air will inflate the ſides of the great omentum, and give it the appearance of a large bladder irregularly divided into ſeveral lobes or tubercles by the bands of fat, which appear in this ſtate like ſo many fraena between the lobes.

To be ſure of ſucceeding in this experiment, the two omenta muſt be in their natural ſtate, and they muſt be handled very gently with the fingers firſt dipped in oil. It ſucceeds

ceeds better in young lean ſubjects than in old or fat ſubjects.

When we touch theſe membranes with dry fingers, they ſtick to them ſo cloſely, as hardly to be ſeparated without being torn, as we ſee by the reticular holes which appear in thoſe portions of membranes that have been thus handled. In that caſe it is to no purpoſe to blow through the natural orifice already mentioned; and it is owing to theſe ſmall holes that the membranes of the omentum have been ſuppoſed to be naturally reticular.

The membranous laminae of the little omentum are continuous, partly with the external membrane of the liver, partly with that of the ſtomach, and a little with the membrane that lines the neighbouring portion of the diaphragm. Thoſe of the great omentum are continued partly with the ſame coat of the ſtomach, and partly with the external covering of the colon, and conſequently with the meſocolon; and they likewiſe communicate with the covering of the ſpleen.

We may ſatisfy ourſelves concerning theſe continuations, by making a ſmall hole in one of the laminae of the omentum near the ſtomach, colon, &c. and by blowing into that hole, through a pipe well fitted to it; for the air will gradually inſinuate itſelf under the common coats of theſe viſcera; but, if the parts be dry, they muſt be moiſtened a little before the experiment is made.

Appendices epiploicae. The fatty appendices of the colon and rectum are conſidered by Winſlow as a kind of ſmall omenta or appendices epiploicae. They are ſituated at different diſtances, along theſe inteſtines, being particular elongations of their common or external coat. They are of the ſame ſtructure with the great omenta; and there is a cellular ſubſtance contained in their duplicature, more or leſs filled with fat, according as the ſubject is fat or lean.

Next

Next the inteſtine, each of them forms a broad thin baſis; and they terminate by a regular papillae, thicker than their baſes. Theſe baſes are at firſt diſpoſed longitudinally; then obliquely; and, laſtly, more or leſs tranſverſely, eſpecially near the rectum, and upon that inteſtine.

Theſe appendices are for the moſt part ſeparated from each other; but ſome of them which have longitudinal baſes communicate together, the veſtiges of theſe communications being very narrow, and not very prominent. By blowing through a ſmall hole made in one of theſe appendices, it is inflated like a ſmall irregular bladder, and the air paſſes under the external coat of the colon or rectum.

Beſides theſe appendices epiploicae, we obſerve, at different diſtances, along the colon, between the ligamentary band, which lies hid, and one of the other two, that is, on both ſides of the adheſion of the meſocolon, ſeveral adipoſe ſtrata, which may likewiſe be conſidered as appendices of the ſame nature with the former; but theſe ſtrata are very ſeldom obſerved between the two apparent ligamentary bands of the colon.

Veſſels of the omentum. The arteries and veins of the great omentum are branches of the gaſtricae, and, for that reaſon, go by the name of *gaſtro-epiploicae dextrae* and *ſiniſtrae*. The arteries on the right ſide anſwer to the hepatic artery, and thoſe on the left ſide to the ſplenic; and both communicate with the arteria ventriculi coronaria, and reſpectively with the arteriae meſentericae. The gaſtro-epiploic veins anſwer in the ſame manner of diſtribution to the vena portae.

The veſſels of the little omentum come chiefly from the coronariae ventriculi; and thoſe of the appendices and ſtrata are ramifications from the reticular texture of the arteries and veins of the colon and rectum.

§ 17.

§ 17. *Secretion of the Bile.*

THE *liver* being the largeſt of all the viſcera, fills up a very large part of the abdomen in its upper chamber, above the meſocolon; and is ſtill larger, in proportion, in the foetus. It is ſurrounded on all ſides by the neighbouring viſcera, and fixed by ligaments in ſuch a manner as to be ſuſpended in the body, with a conſiderable degree of firmneſs; yet ſo as to be allowed a conſiderable liberty to move and be variouſly agitated, raiſed, and depreſſed, by the actions of the diaphragm.

This large viſcus is ſupplied with veſſels of various kinds. For, beſides the arteries, it has the vena portarum, which receives all the blood of the ſtomach, inteſtines, meſentery, ſpleen, omentum, and pancreas, by two trunks; viz. the tranſverſe ſplenic and aſcending meſenteric; and afterwards by one which is continued with the meſenteries. This is large, compoſed of ſtrong membranes, and ſurrounded with much denſe ſhort cellular ſubſtance, derived to it from the meſentery and ſpleen, and adding ſtrength to its membranes, which are ſtronger than thoſe of the aorta. Many of the ſmaller veſſels and hepatic nerves, which all come together under the denomination of a *capſula*, are intermixed with this cellular ſubſtance. By this the vena portarum is conducted to the liver, and firmly ſuſtained; inſomuch that the branches, being cut, do not collapſe, but preſerve their round appearance. Each branch of this veſſel is divided into many others, again divided and ſubdivided, like the arteries, till they at length produce the ſmalleſt capillaries. In this courſe every branch of the vena portarum is accompanied with a concomitant branch of the hepatic artery, creeping upon the ſurface of the vein, and upon the contiguous hepatic ducts, almoſt in the ſame manner as the bronchial arteries uſually

creep

creep along the ramifications of the trachea in the lungs: while, in the mean time, both the artery and the vein are connected to the branches of the biliary ducts by a thin cellular ſubſtance like a ſpider's web. Some branches go out of the liver, being divided to the ligaments, and inoſculating with the ſurrounding veins. And the ſum of the branches in the vena portarum is always greater than the trunk; whence the area of the ſections of all the branches together greatly exceed that of the trunk; from whence follow a great friction and reſiſtance, in the ſame manner as in the arteries.

The blood brought to the liver by the vena portarum and hepatic artery muſt of courſe be conveyed back again by ſome other veins; and therefore the extreme branches of the vena portarum and hepatic artery inoſculate ultimately into other veins, which are *branches of the cava*. Theſe branches ariſe from the whole circumference of the liver, run together towards its poſterior gibbous part into branches and trunks, and at laſt go off into ten or more large veſſels. The greater number of theſe leſſer trunks paſs out through the poſterior lobule of the liver, and go to the cava through the ſulcus that lies on the right ſide of the lobule, often completed into a circle by a ſort of bridge or production of the liver; from whence they aſcend together through the diaphragm towards the left ſide. Two or three trunks, much larger than the former, are inſerted into the cava, cloſe to the diaphragm, whoſe veins they often take in by the way. The branches of the vena cava are, in the adult, generally fewer and leſs than thoſe of the vena portarum; which is an argument that the blood moves quicker, becauſe of the leſs friction, and of the collection of the blood into a leſs capacity, by which it is always accelerated when there is a ſufficient compreſſing force. As to any valves at the openings of theſe branches into the cava, there are none which deſerve to be regarded. The trunk of the vena cava paſſes through the foramen of the diaphragm,

diaphragm, obtuſely quadrangular, and ſurrounded and terminated by mere tendons, ſo as to be not eaſily changeable. Having ſurmounted this opening of the diaphragm, it then immediately expands into the right auricle. The ſmaller veins of the liver creeping about its ſurface are ſent into the phrenics, renals, and azygos; or, at leaſt, there is certainly a communication between theſe and the hepatic veins coming from the portae.

That the blood comes from all parts by the vena portarum to the portae, is proved by a ligature, by which any vein between theſe parts and the ligature ſwells; but the porta itſelf, above the ligature, grows flaccid and empty. That it afterwards goes through the liver to the cava, appears by anatomical injections, which ſhew open and free anaſtomoſes or communications between the vena portarum and the cava; and by the common nature of the veins going to the cava. Again, the difficult paſſage through the vena portarum, like to that of an artery, together with its remoteneſs from the heart, and the oily or ſluggiſh nature of the blood itſelf, occaſion the blood to ſtagnate, accumulate, and form ſcirrhous ſwellings in no part oftener than in the liver. This danger however is diminiſhed by the motion of the adjacent muſcles, and by reſpiration; but it is increaſed by inactivity, and by ſour and viſcid aliments. Hitherto, we have been ſpeaking of the adult liver, in which both the umbilical vein and the ductus venoſus are empty and cloſed up, although they continue to cohere with the left branch of the vena portarum.

The *nerves* of the liver are rather numerous than large; hence, when wounded or inflamed, it is capable of no very great pain.

The *lymphatic veſſels* of the liver are numerous, ariſing from all ſides, and paſſing into the thoracic duct.

Through the whole ſubſtance of the liver go bundles of biliary veſſels, of branches of the vena portarum, and of the hepatic

hepatic artery. Each veſſel has its proper cellular texture ſurrounding it, and ligaments, by which it is tied to its fellow veſſels; and, laſtly, the whole bundle has its cellular texture round it. The branches of the vena cava lie on the outſide of the reſt, being leſs accurately received into the ſame bundle. The ultimate ſmall branches of the vena portarum, cava, and hepatic artery, together with the bilious ducts, are united together by means of the cellular ſubſtance into compound cluſters, ſomewhat reſembling mulberries, commonly called *acini*, of an hexagonal ſhape, ſurrounded with a lax cellular texture. In theſe acini, likewiſe, there are mutual anaſtomoſes between the portal branches and hepatic artery, with the roots of the vena cava on one ſide, and the firſt organs of the pori biliarii of the liver on the other ſide; which laſt inoſculations are demonſtrated by anatomical injections; for liquors injected by the vena portarum return again through the ductus cholidochus.

Many eminent anatomiſts have taught, that the fore mentioned acini are hollow, having arteries and veins ſpread upon their external ſurface, and that they depoſit the bile into their cavity, after it has been ſecreted from the branches of the vena portarum. This opinion they ſupport by arguments taken from comparative anatomy, theſe acini being in brutes rounder and more defined than in man; and from diſeaſes, in which we find cells and round tubercles, filled with lymph, chalk, and various kinds of concreted matter. To this they might have added the thick ſluggiſh nature of the bile itſelf, its ſimilarity to mucus, and the analogy of the follicles of the gall-bladder.

But greater accuracy in anatomy will not allow any follicles into which the ſmall ſecretory veſſels open; for ſuch follicles would intercept the courſe of anatomical injections, and give us the appearance of knots, intermediate between the ſecretory veſſels and the biliary pores, which we have never yet been

able to ſee; for the wax flows immediately into a cavity, in a continued thread from the vena portarum into the biliary ducts, without any interruption or effuſion. Again, a follicular or glandular fabric is not allowable in the liver, from the great length of the biliary ducts. For all follicles depoſit their contents into ſome ſpace immediately adjacent; for they are unfit to convey their ſecerned fluid to any length, as they deſtroy a great part of the velocity imparted by the arteries. Laſtly, the common preſſure, which we muſt ſuppoſe to be on theſe acini, would ſo cruſh them, that no aſſiſtance could from thence be brought to promote the motion through the excretory ducts. Concretions and hydatids are formed in the cellular ſubſtance; and, laſtly, the bile, when firſt ſecreted, is ſufficiently fluid.

Haller is perſuaded that no bile is ſeparated from the hepatic artery; becauſe the peculiar ſtructure of the vena portarum would be uſeleſs if it ſecreted nothing. Its office in ſecretion appears plainly by the continuations of its branches with the biliary ducts, in a manner more evident than that of the artery; but it appears by experiments, alſo, that the biliary ſecretion continues to be carried on after the hepatic artery is tied; add to this the largeneſs of the biliary ducts, in proportion to ſo ſmall an artery, with the peculiar nature of the blood collected in the vena portarum, ſo extremely well fitted for the formation of the bile. But in the blood of the hepatic artery, ſays Haller, we can find nothing peculiarly fit for the ſecretion of bile, or analogous to its nature.

Since, therefore, the vena portarum conveys the blood ready charged with biliary matter, fit to be ſecreted in the leaſt acini, and from thence there is an open free paſſage, without any intermediate follicles, from the ultimate branches of the vena portarum into the beginning roots of the biliary ducts, and that the humours driven into the vena portarum may eaſily chooſe this paſſage, the bile will be expelled from thence

thence by the force of the blood urging behind, as well as by the auxiliary force of the diaphragm preſſing the liver againſt the reſt of the viſcera in the abdomen when full; and again, the diaphragm contracted in exſpiration, will force the bile into the larger branches, and laſtly into the two trunks of the *ductus biliarius hepaticus*; which trunks meet together upon the vena portarum, in the tranſverſe foſſa of the liver, near the anonymous lobule.

The fabric of this duct is like that of the inteſtines, except that there do not appear to be any muſcular fibres. From experiments it appears to be endowed with a moderate degree of irritability. That it is vaſtly dilatable, and extremely ſenſible, is ſhewn from diſeaſes.

The hepatic duct goes on upon the vena portarum, more to the right than the artery, towards the pancreas; and then deſcending obliquely, covered by ſome part of that gland, it goes to the lower part of the ſecond flexure of the duodenum, and is inſerted backward about four or five inches from the pylorus, through an oblique oblong ſinus made by the pancreatic duct, into which it opens by a narrow orifice. This ſinus runs a great way through the ſecond cellular coat of the duodenum obliquely downward; then it perforates the nervous coat, and goes on again obliquely between it and the villous coat; and, laſtly, it opens into a protuberant long wrinkle of the duodenum. There is almoſt the length of an inch taken up between the firſt inſertion, and the egreſs of this duct through the coats of the duodenum; by a ſinus which ſurrounds and receives the ductus cholidochus, in ſuch a manner, that when the coats of the inteſtine are diſtended by flatus, or cloſely contracted by a more violent periſtaltic motion, the opening of the duct muſt be conſequently compreſſed or ſhut; but when the duodenum is relaxed and moderately empty, the bile then has a free exit. Any regurgitation from the duodenum is hindered by this obliquity and wrinkling

wrinkling of the duct, for it may be very eaſily preſſed together or cloſed; the regurgitation may alſo be prevented by a ſucceſſion of freſh bile deſcending perpendicularly from the liver. Air inflated into the inteſtine finds no paſſage into the duct.

Juſt at the portae this duct receives from the gall-bladder another leſs canal of the ſame kind, which lies for a good way parallel with it, and is inſerted into it by a very acute angle: This, which is called the cyſtic duct, from its origin, is ſometimes firſt increaſed by another ſmall duct from the liver before its inſertion. The gall-bladder, from which this duct riſes, is a peculiar receptacle for the bile: Moſt animals are furniſhed with it; ſome, however, want it, as moſt of the ſwift running, and many of the herbivorous animals. Its ſituation, figure, and texture, has been already deſcribed.

The generality of animals have, between their gall bladder and liver, or between the ducts coming from both, ſome peculiar openings in the gall-bladder, into which ſome ducts, originating from the liver, or the hepatic biliary duct, diſcharge their contents. In man theſe ducts have not been hitherto clearly demonſtrated; and the gall-bladder is eaſily looſened from the liver, without a drop of bile diſtilling either from it or from the liver. There is alſo a thin water in the bladder as often as the cyſtic duct is obſtructed.

The bile flows naturally both out of the bladder and liver, as long as there is no impediment in its way; ſo that both ducts ſwell when that paſſage is obſtructed, and the cyſtic lies in a ſtraight line with the cholidochus. There is no neceſſity for all the bile to be diverted into the gall-bladder before it flows into the duodenum. There is not a perpetual obſtacle which hinders the afflux, and peculiarly reſiſts the hepatic bile, and admits the cyſtic; the paſſage into the ductus cholidochus is larger and ſtraighter, the ductus cyſticus much leſs than the hepatic, nor is that duct ſo well

formed

formed for receiving all the bile; the cholidochus being much larger than the cyſtic duct, cannot therefore be made only for the reception of its bile. There are many animals in which the hepatic duct diſcharges its contents into the inteſtine without any communication with the cyſtic. In living animals, even when the cyſtic duct is free, the bile appears to deſcend into the duodenum in a perpetual current. That the quantity is very conſiderable, appears from the magnitude of the ſecretory organ, and the excretory duct, ſo many times larger than the ſalival ones, and from diſeaſes, in which four ounces of the cyſtic bile have flowed through an ulcer of the ſide daily. The hepatic bile goes into the bladder, as often as there is any obſtruction in the duodenal ſinus, from flatus or any other cauſe compreſſing the end of the ductus cholidochus. Accordingly, we find it extremely full, whenever the common biliary duct is obſtructed or compreſſed by ſome ſcirrhous tumor, whence the gall bladder is ſometimes enlarged beyond all belief; and if the cyſtic duct be tied, it ſwells between the ligature and hepatic duct; and in living animals, the hepatic bile viſibly diſtils into the wounded gall bladder. The retrograde angle, or direction of this duct, is not repugnant to ſuch a courſe of the bile; for a very ſlight preſſure urges it from the liver into the gall-bladder, and even air may be eaſily driven the ſame way, more eſpecially if the duodenum be firſt inflated. There does not ſeem to be any ſort of bile ſeparated by the gall-bladder itſelf; for whenever the cyſtic duct is obſtructed by a ſmall ſtone, or a ligature made upon it, we find nothing ſeparated into the gall-bladder more than the exhaling moiſture, and a ſmall quantity of inſipid mucus ſecreted from the follicles. In many animals, we meet with no appearance of any gall-bladder, when at the ſame time there is a plentiful flux of ſtrong, well prepared, and ſalutary bile diſcharged into the inteſtines. Again, it does not ſeem probable, that the cyſtic branch

branch of the vena portarum can ſeparate bile into the gall-bladder; for that vein in itſelf is a mere reconductory veſſel: Nor can any be ſeparated from the hepatic artery; for it muſt be vaſtly beyond probability, that ſuch a ſtrong bile as that of the gall-bladder ſhould be ſeparated from a milder blood than that from which the mild hepatic bile is prepared.

Laſtly, the bile flows alſo from the gall-bladder to the liver, and at length returns into the blood, when its paſſage into the inteſtines is totally intercepted. A latent cauſe in the nerves may alſo occaſion this regurgitation. This paſſage or abſorption of the bile into the ſyſtem is pernicious, and is the occaſion of jaundice; which, when the offending ſtones or concretions are removed, is cured by the bile's free courſe into the duodenum being reſtored.

A portion of the hepatic bile being received into the gall-bladder, there ſtagnates, and is only a little ſhaken by reſpiration. By degrees it there exhales its thinner parts, which we ſee penetrate and filtrate through the adjacent membranes. The remainder being a fluid of an oily ſubalkaline nature, digeſted in a warm place, grows ſharp, rancid, more thick, bitter, and of a high colour: For this is the only difference between the cyſtic and hepatic bile; the later being weaker, leſs bitter, lighter coloured, and of a thinner conſiſtence, while it remains within its proper hepatic ducts. That the difference between them proceeds only from ſtagnation, appears from ſuch animals as have only a larger porus hepaticus, inſtead of a gall-bladder; for here we find the bile, which ſtagnates in the larger hepatic pore, is conſiderably more bitter than that in the ſmaller pores of the liver; as, for example, in the elephant. But the gall-bladder gives this particular advantage, that it receives the bile when the ſtomach, being empty, has no need for it, that afterwards it may be able to return it in greater plenty, when we princi-

pally

pally want it for the digeſtion of the aliments now flowing in great quantity into the duodenum. This flow of the bile is quicker, in proportion through the cyſtic duct, as the ſection of that duct is leſs than the ſection of the gall-bladder.

The gall-bladder hardly touches the ſtomach, but the beginning of the deſcending duodenum. When the ſtomach is extremely diſtended, and the abdomen very full, it makes a conſiderable preſſure both upon the liver and duodemum; by which the gall-bladder is preſſed, and its bile forced out. Thus the bile flows through a free paſſage from the gall-bladder into the common duct and the duodenum: And this it does more eaſily in perſons lying on their back; in which poſture the gall-bladder is inverted, with its bottom upward. Hence it is that the gall-bladder becomes ſo full and turgid after faſting. The expulſive force of the bile is but little more than that of the preſſure received from the ſtomach and diaphragm; for, as to any muſcular force reſiding in the fibres of the proper membrane, which may be thought to contract the gall-bladder, it muſt be very weak and inconſiderable.

The hepatic bile is always bitter, but the cyſtic is more ſo; always viſcid; of a full yellow colour, with a tincture of green; miſcible, by triture, either with water, oil, or vinous ſpirits; coagulable by mineral acids; diſſoluble by alkalies, eſpecially the volatile; and extremely well adapted to diſſolve oily, reſinous, or gummy ſubſtances; quickly putrefying, and by putrefaction ſpontaneouſly degenerating to a muſk-like odour. Its chemical analyſis, and experiments of mixture with various ſubſtances, demonſtrate, that it contains a large portion of water, and a conſiderable quantity of inflammable oil, which appears very evidently in gall-ſtones. The bile, therefore, is a natural ſoap; but of that ſort which is made from a volatile ſaline lixivium, mixed with oil and water. This, therefore, being intermixed with the aliment, reduced to a

pulp,

pulp, and ſlowly expreſſed from the ſtomach by the periſtaltic force of the duodenum and preſſure of the abdominal muſcles incorporates them all together; and the acid or aceſcent qualities of the food are in ſome meaſure thus corrected, the curd of milk is again diſſolved by it into a liquid, and the whole maſs of aliment inclined more to a putrid alkaleſcent diſpoſition; it diſſolves the oily matters, ſo that they may freely incorporate with the watery parts, and make up an uniform maſs of chyle to enter the lacteals; the ſurrounding mucus in the inteſtines is hereby abſterged and attenuated, and their periſtaltic motion is excited by its acrimony; all which offices are confirmed, by obſerving the contrary effects from a want or defect of the bile. Nor is the hepatic bile ſufficient to excite the neceſſary motion of the inteſtines, if the cyſtic is wanting; both which are of ſo much uſe and importance to the animal, that we find, by experiment, even the ſtrongeſt animal will periſh in a few days, if the flux of bile to the inteſtines be intercepted, by wounding the gall-bladder.

The bile deſcends ſlowly along with the alimentary maſs; and having ſpent its force, or changed its bitterneſs by putrefaction, moſt of it is afterwards excluded with the feces; but probably ſome of the more ſubtile, watery, and leſs bitter parts, are again taken up by the abſorbents. It returns with difficulty into the ſtomach, becauſe of the aſcent of the duodenum, which goes under the ſtomach; becauſe of the reſiſtance it meets with from the valvula pylori; and becauſe of the advancement of the new chyle which the ſtomach adds to the former: in man, however, it frequently enters; and always in birds. The bile is ſweet and mild in the foetus; for in them the blood ſeems not ſufficiently charged with putrid alkaline vapours, nor are there any oily or fat ſubſtances abſorbed from the inteſtines. As the bile is a viſcid fluid, in lazy, inactive, and fat animals and men, eſpecially if,

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from grief or any other cauſes, the circulation is rendered more languid, it eaſily coagulates into an hard, ſomewhat reſinous, and often ſtony ſubſtance, inſomuch that ſtones of the gall are much more frequent, as experience teaches us, than thoſe of the urinary bladder. Its uſe is manifeſt, as, being triturated with the aliments, it diſſolves oil, reſiſts acidity, and ſtimulates the inteſtines to contraction.

The uſe of the liver, beſides ſecreting the bile, is manifeſt in the foetus. It ſeems to tranſmit the blood brought back from the placenta, and to break its force. Even in an adult perſon it has the ſame uſe, though leſs manifeſtly, namely, to retard the return of the blood coming back from the viſcera appointed for preparing the chyle.

§ 18. *Renes et Ureteres.*

Situation, figure, and diviſion of the kidneys. The kidneys are two ſolid glandular bodies, ſituated in the poſterior part of the cavity of the abdomen, on each ſide of the lumbar vertebrae, between the laſt falſe ribs and os ilium. The right kidney lies under the great lobe of the liver, and is conſequently lower than the left, which lies under the ſpleen.

The figure of the kidneys reſembles that of a large bean, their circumference being convex on one ſide, and concave on the other. The concave ſide is turned to the vertebrae, and the convex ſide the oppoſite way. Their length anſwers to the diſtance between the laſt falſe rib and os ilium; they are about half as broad as they are long, and half as thick as they are broad.

In each kidney we obſerve a fore and back ſide, an upper and lower extremity, a great and ſmall curvature, and a convexity and concavity.

The backſide is broader than the foreſide; and the upper extremity is a little broader and more incurvated than the lower. The depreſſion in the ſmall curvature is oblong and

uneven, reſembling a ſinus, ſurrounded by ſeveral tubercles; and, as it is turned a little toward the foreſide, this ſide is ſomething narrower than the other.

Blood veſſels of the kidneys. The deſcending aorta and inferior vena cava lie between the kidneys, cloſe to the bodies of the vertebrae and to each other; the artery being on the left ſide, and the vein on the right. The renal artery commonly comes from the ſide of the aorta under the ſuperior meſenteric artery: That of the left ſide has its origin a little higher and further back than that of the right ſide; and both having run over almoſt at right angles, enter the ſinus of the kidney, and divide into many branches, which ſubdivide into many others ſtill ſmaller. The renal veins have leſs variety than the arteries. It is ſeldom we find more than one on each. From each kidney ſeveral branches come out, which ſoon unite to form a trunk, which ends in the vena cava. Theſe veſſels were by the antients termed the *emulgent arteries and veins*, but they frequently go under the name of *arteriae et venae renales*.

The artery and vein are not of an equal length, and the difference depends on the ſituation of the aorta and vena cava; for the left renal artery is ſhorter than the right, becauſe the aorta lies neareſt the left kidney; and the left renal vein is longer than the right, becauſe the vena cava lies furtheſt from the left kidney.

Theſe veſſels are likewiſe diſpoſed in ſuch a manner, as that the veins lie more anteriorly than the arteries; becauſe the aorta lies cloſe to the ſpina dorſi; whereas the vena cava, which perforates the diaphragm at ſome diſtance from the vertebrae, does not join them till after it has given off the renal veins.

Nerves of the kidneys. Each artery is ſurrounded by a nervous net-work, called *plexus renalis*; which furniſhes a great number of filaments to the kidneys, that come partly from the ſemilunar ganglions of the two great ſympathetic nerves, and

and partly from the plexus hepaticus and ſplenicus. This renal plexus ſends likewiſe ſome filaments round the renal veins.

Coats of the kidneys. The kidneys are ſurrounded by a very looſe membranous and cellular covering, called *membrana adipoſa*; becauſe, in fat perſons, the cells of this ſubſtance are filled with fat. This was for a long time improperly taken for a duplicature of the peritonaeum; the true membranous lamina of which covers only the foreſide of the kidneys, and conſequently they lie without the peritonaeum, becauſe the portion of that membrane which covers them cannot be conſidered as an entire coat: So that the only common coat they have is the cellular ſubſtance, which likewiſe inveſts the renal arteries and veins in form of a vagina.

The proper coat or membrane of the kidneys is ſtrong and denſe, and adheres very cloſely to their ſurface; for it penetrates every where by numerous elongations into their ſubſtance, from which it cannot be ſeparated without tearing.

The external ſurface of this lamina is very ſmooth, poliſhed, and ſhining; and it renders the whole ſurface of the kidney very even and uniform in adults. In children, this convex ſurface is in a manner divided into ſeveral lobes and tubercles almoſt as in oxen and calves; and in grown perſons we ſometimes obſerve the ſame inequalities.

The blood-veſſels having entered the kidneys, are ramified every way; and theſe ramifications ſend out other capillary rami, which go all the way to the ſurface, where they appear like irregular ſtars, and furniſh the proper membrane of the kidneys. Sometimes theſe two ramifications penetrate to the membrana adipoſa, and communicate there with the arteriae and venae adipoſae.

The proper membrane having ſurrounded the kidney all the way to the ſinus, joins the veſſels at that place, and accompanies all their ramifications through the body of the kidney,

kidney, in form of a vagina or capſule, and likewiſe contributes, in part, to form the pelvis and calices, or infundibula; of which hereafter.

We ſometimes obſerve a conſiderable veſſel to go in or come out from the convex ſurface of the kidney; but this is not common; and in that caſe there is a depreſſion, by which the proper membrane enters, and communicates with that portion which goes in by the ſinus.

The tunica adipoſa, or common coat, which likewiſe inveſts the great veſſels till their entry into the kidneys, does not ſeem to accompany them any further, but terminates at the ſinus, in the interſtices between the ramifications.

Structure of the kidneys. We may diſtinguiſh three kinds of ſubſtances in the kidney; an exterior ſubſtance, which is thick, granulated, and in a manner cortical; a middle ſubſtance, which is medullary and radiated, called *ſtriata*, *ſulcata*, or *tubularis*, becauſe it ſeems to be made up of radiated tubes; and an inner ſubſtance, which is only a continuation of the ſecond, and terminates on the inſide by papillae; for which reaſon it goes under the name of *papillaris*.

Theſe three ſubſtances may be ſeen diſtinctly in a kidney cut into two equal parts, through the great curvature. The cortical ſubſtance may be obſerved round the whole circumference; and, by the microſcope, we perceive it to be of a ſpongy, granulated, and waving texture; all its parts adhering together in a radiated manner. Its colour is a bright whitiſh grey.

By fine anatomical injections and inflammations, we diſcover an infinity of ſmall capillary veſſels, which run in various directions between and round the different portions of this ſubſtance; and, by the help of a microſcope, we ſee likewiſe great numbers of ſmall red corpuſcles more or leſs round, and diſpoſed almoſt like bunches of currants. Thoſe

ſmall

ſmall corpuſcles are perhaps only the extremities of veſſels, filled either with blood, or with a coloured injection.

The other two ſubſtances, that is, the medullary or ſtriated, and the papillary, are really but one and the ſame maſs, of a more reddiſh colour; the convex ſide of which riſes at ſeveral places into narrow tubercles, lodged in the ſame number of cavities or depreſſions. The radiated ſtriae are afterwards continued to the papillary portion; and the papillae form, in ſome meaſure, ſo many centres of theſe radii, oppoſite to the tubercles.

The medullary ſubſtance is likewiſe diſtinguiſhed from the cortical, by the arterial and venal arches, which ſend capillary ramifications on all hands; and its colour is more or leſs red.

The papillae, which are only a continuation of the medullary ſubſtance, as has been ſaid, are often a little paler than that ſubſtance. They are ten or twelve in number, very diſtinct from each other, reſembling the ſame number of cones, with very broad baſes and obtuſe apices.

At the point of each papillae we ſee, even without a microſcope, in a ſlight depreſſion, ſeveral very ſmall holes, through which little drops may be perceived to run when the papillae are compreſſed. Theſe are little drops of urine, which, being filtered, partly in the cortical, partly in the medullary or tubular ſubſtance, afterwards paſs through the ſubſtance of the papillae, and are diſcharged by theſe orifices.

The pelvis of the kidneys. Each papilla lies in a kind of membranous calix or infundibulum, which opens into a common cavity, called the *pelvis*. This pelvis is membranous, being of the ſame ſtructure with the calices, of which it is a continuation; and its cavity in man is not uniform, but diſtinguiſhed into three portions, each of which contains a certain number of infundibula or calices, together with the papillae

pillae which lie therein; and ſometimes we find two or three papillae in the ſame infundibulum.

At the place where theſe infundibula ſurround the baſes of the papillae, they ſend productions into the medullary or radiated ſubſtance of the kidney, which accompany the blood-veſſels, and ſerve for capſules or vaginae to all the vaſcular arches, both arterial and venal, and to their different ramifications, quite through the cortical ſubſtance, and as far as the ſurface of the kidney.

Ureters. After the infundibula have contracted in a conical form round the apices of the papillae, each of them forms a ſmall ſhort tube or gullet, which uniting at different diſtances along the bottom of the ſinus of the kidney, form three large tubes which go out from the ſinus, in an oblique direction from above downwards, and immediately afterwards unite into one trunk.

This trunk becomes a very long canal, called the *ureter*. In men, the three tubes ſupply the place of what is called the *pelvis* in brutes, and might more properly be called the *roots* or *branches* of the ureters than the pelvis; which name would agree beſt to the trunk, as being larger than the reſt of the ureter. The ureters are commonly two in number, one for each kidney; but ſometimes there are more than two.

The ſituation of the trunk, and of the roots and branches of each ureter, with reſpect to the renal artery and vein, is in the following manner: The artery is in the upper part of the ſinus, and partly before the vein. The vein is about the middle, and between the artery and ureter. The ureter is in the lower part, a little behind the vein, and it is partly ſurrounded by one branch of the artery.

This diſpoſition appears plainer near the anterior than near the poſterior ſide of the kidney, becauſe this laſt is broader than the former; and we likewiſe ſee there the three branches,

branches of the ureter; of which the uppermoſt is the longeſt, and the loweſt is the ſhorteſt, becauſe of their oblique direction downward.

From this deſcription, we ſee, that in the human kidney there is no other common or uniform pelvis, but the trunk or head of the ureter, and the three great branches. To have a true idea of their diſpoſition, we muſt imagine that the ureter enters the kidney by the lower part of the oblong ſinus; that it increaſes gradually in breadth as it advances; and that it is divided into three branches before it enters the ſubſtance of the kidney.

One of theſe branches may be reckoned a direct continuation of the ureter, and it is longer than the reſt, being extended from the lower to the upper part of the ſinus; and it may be found without much preparation. The other two branches are ſhorter, and cannot be well diſcovered without an artificial ſeparation. The angles between theſe branches at their baſis, or at the head of the ureter, are not pointed as thoſe of other ramifications, but formed by a round incurvation, which is generally ſurrounded by fat.

Theſe firſt branches of the ureters produce other ſmall branches at the bottom of the ſinus, which are diſpoſed in pairs. Theſe ſmall collateral branches extend in breadth, and form the infundibula or calices, in which the papillae are lodged; the great circumference of which produces, in the ſubſtance of the kidney, the different vaginae of the vaſcular arches and of their ramifications. The internal lamina of the kidney is continued round theſe vaginae; and the external lamina is expanded round the firſt branches, round the trunk, and round all the reſt of the ureter.

If the trunk of the ureter be ſplit on that ſide which is next the vertebrae, and this ſection be continued to the extremity of the ſuperior branch, we may obſerve, immediately above the trunk, two holes lying near each other, which are

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the orifices of the ſmall collateral branches and gullets of the infundibula. A little above theſe holes, there are other two very much like them, and ſo on all the way to the extremity of the ſuperior branch, which terminates likewiſe by theſe gullets of the infundibula; and in each of theſe gullets we may obſerve at leaſt the apex of one papilla.

A ſection begun on the convex ſurface of the kidney, and carried from thence to the trunk of the ureter, diſcovers the extent of the papillae very plainly, and likewiſe the infundibula, their gullets, &c.; but it will be difficult to give beginners a juſt idea of the ſtructure of theſe parts without the other ſection.

The ureters run down obliquely, and with a very ſmall degree of inflection, from the kidneys to the lateral parts of the inner or anterior ſide of the os ſacrum; and paſſing between the rectum and the bladder, they terminate in the laſt of theſe viſcera, in the manner that ſhall be explained hereafter.

They are compoſed of three proper coats; the firſt of which, that ſurrounds the reſt, is of a whitiſh colour, and of a very compact filamentary texture, being ſtretched with difficulty, and appearing like a filamentary ſubſtance degenerated. The next coat is of a reddiſh colour, ſtronger than the firſt, and is compoſed of muſcular fibres, although this has been doubted by ſome authors.

The innermoſt coat is in ſome meaſure ligamentary, and lined by a very fine membrane, which covers a very delicate reticular texture of veſſels, and is moiſtened all over by a mucilaginous liquor.

Beſides theſe proper coats, the ureters are inveſted by the cellular ſubſtance of the peritonaeum, the membranous lamina of which covers likewiſe about two thirds of their circumference, ſometimes more, ſometimes leſs, but never ſurrounds them entirely: So that when they are examined in their

their natural ſituation, they appear like ropes lying behind the peritonaeum, and jutting out more or leſs toward the cavity of the abdomen, together with that portion of the peritonaeum which covers them.

All that has been ſaid about the ſtructure of the ureters, pelvis, arches, ſtriae, foſſulae, and holes at the apex of the papillae, appears moſt diſtinctly when they are examined in clear water.

§ 19. *Glandulae Renales, vulgo Capſulae Atrabiliariae.*

Situation, figure, and ſize of the renal glands. Immediately above each kidney lies a glandular body, called by the antients *capſulae atrabiliariae;* by others, *capſulae renales*, *renes ſuccenturiati*, and *glandulae renales;* and they might be properly enough termed *glandulae ſupra renales*. They are ſituated on the upper extremity of each kidney a little obliquely, that is, more toward the inner edge and ſinus of the kidney, than toward the outer convex edge.

Each gland is an oblong body with three ſides, three edges, and two points, like an irregular creſcent with its great or convex edge ſharp, and the ſmall concave edge broad. Its length is about two thirds of the greateſt breadth of the kidney, and the breadth of its middle portion is about one third of its extent between the two extremities, ſometimes more, ſometimes leſs. Its colour is a dark yellow.

It has one anterior, one poſterior, and one lower ſide, which laſt may be termed the *baſis;* and it has one upper, and two lower edges, whereof one is anterior, the other poſterior. The upper edge may be called *criſta*, and the two lower edges the *labia*. One of its extremities is internal, or turned inward toward the ſinus of the kidney, the other is external or turned outward toward the gibbous part of the kidney. The figure of this glandular body may likewiſe be compared to that of a cock's-comb, or to the top of an helmet.

Structure of the renal glands. The surface of these glands is uneven; the fore-side is the broadest, and the lower side or basis the narrowest. Along the middle of the anterior side, a ridge runs from the edge of the inner extremity a little above the basis, to the point of the other extremity, and divides this side into two equal parts, like the middle rib of the leaf of a tree, and on the lower side, under the basis, there is a kind of raphe or suture.

The arteries of these glands come from the arteriae renales and diaphragmaticae, and likewise from the aorta, from the arteria caeliaca, &c. These vessels are termed the *capsular arteries;* and as they enter the glands, they seem to be invested by a vagina. They are not always derived from the same sources, neither is their number the same in all subjects; and there is commonly a large vein which runs along the ridge. One principal vein returns the blood from each of these glands; the right goes into the vena cava, the left passes into the renal vein. The nerves on each side are furnished by the neighbouring semilunar ganglion, and by the renal plexus which depends on it.

In the inside of these capsulae, there is a narrow triangular cavity, the surface of which is full of short strong villi of a yellowish colour; but in children it is reddish, and of a dark brown in aged people. The sides of this cavity are connected by a greater number of filaments; and they appear to be wholly glandular, that is, to be filled with very fine small folliculous corpuscles. Along the top of the gland these sides touch each other immediately.

In opening this cavity, we find a granulated or follicular substance, which fills it almost entirely; and the blood-vessels are distributed on this substance, as well as on the sides of the cavity. If the section be begun at the great extremity of the capsula, and be continued through the upper edge, and if the lateral portions be afterwards separated, the glandular body

body appears like a kind of criſta, raiſed from the middle of the bottom of the cavity.

This glandular body or nucleus adheres more cloſely to the bottom or baſis of the cavity, than to the two ſides, eſpecially near the great extremity; but yet it may be ſeparated both from the baſis and ſides, being connected to them by a great number of ſmall filaments. It adheres leaſt to the baſis near the ſmall extremity.

The capſular vein, which comes ordinarily from the vena renalis, is much larger than the arteries; and it communicates with the inſide of the capſula much in the ſame manner as the vena ſplenica with the cells of the ſpleen, for it may be inflated by blowing into part of the capſular cavity, and the air likewiſe paſſes into the vena renalis, &c.

The cavity contains an unctous viſcid liquor, of a yellowiſh red colour, which, with age, changes gradually into a yellowiſh purple, a dark yellow, and a black yellow: ſometimes it is perfectly black; but even then if it be ſpread thin on a large ſurface, it appears yellow. It is ſometimes found not only reddiſh, but mixed with real blood.

The uſes of theſe renal glands have not as yet been diſcovered; and all that we know about the liquor contained in them is, that it has ſomewhat the appearance of the bile. They are very large in the foetus, and diminiſh in adults. Theſe two phenomena deſerve our attention.

They lie ſometimes directly on the top of the kidneys, but ſeldom, if ever, on the gibbous part. The gland on the right ſide is partly connected to the diaphragm, under and very near the adheſion of the great lobe of the liver to that muſcle. That on the left ſide adheres to the diaphragm below the ſpleen; and both theſe connections are confined to the contiguous portions of the inferior muſcle of the diaphragm. They are involved, together with the kidneys, in the membrana adipoſa, of which a very thin portion inſinuates itſelf between the

the kidneys and glands, and alſo between them and the diaphragm; ſo that they adhere to both by the intervention of the cellular ſubſtance, which in ſome ſubjects contains a ſtratum of fat.

The venal ridge already mentioned, ſinks ſo deep into the fore-ſide in ſome ſubjects, that the upper part of this ſide appears to be ſeparated from the lower; but this is ſeen moſt diſtinctly when the capſula is examined in clear water.

When the capſular vein is opened length-wiſe with the point of a lancet, we diſcover in it a great many ſmall holes, many of which are only the orifices of the rami of the vein, others are ſimple holes; and it is perhaps through theſe that the air paſſes into the gland, as already mentioned.

On the outer ſurface of theſe capſulae we obſerve a very thin diſtinct coat ſeparated from the cellular ſubſtance that ſurrounds them. Sometimes this coat is raiſed by an uneven ſtratum of fat, which makes it appear granulated; and, for the ſame reaſon, the capſulae are of a pale colour like a corpus adipoſum.

The liquor contained in them appears ſometimes, in the foetus, and in young children, of a bluiſh colour inclined to red.

To be able to diſcover the uſes of theſe capſulae, we muſt not only attend to the two circumſtances already mentioned, but alſo to their external conformation, which is commonly more regular in the foetus and in children than in adults and old people. We muſt likewiſe conſider the conſiſtence and ſolidity of their ſubſtance; which is greater before birth, and in childhood, than in advanced old age; in which they are often very flaccid and very much decayed; and this perhaps may be the reaſon why ſome of the figures given of theſe glands, taken out of their membrana adipoſa, are ſo very irregular and different from others.

CHAP.

CHAP. IV.

Of the PELVIS.

§ 1. *Vesica Urinaria.*

Situation, figure, and division of the bladder.

THE bladder is a kind of membranous and fleshy pouch or bottle, capable of dilatation and contraction, situated in the lower part of the abdomen immediately behind the symphysis of the ossa pubis, and opposite to the beginning of the intestinum rectum. The figure of it is nearly that of a short oval. It is broader on the fore and back sides than on the lateral parts; rounder above than below, when empty; and broader below than above, when full.

It is divided into the body, neck, and bottom; into an anterior, posterior, and two lateral parts The upper part is termed the *fundus* or *bottom*; and the neck is a portion of the lower part, which is contracted like the mouth of some vessels.

Structure of the bladder. The bladder is made up of several coats, almost like the stomach. That part of the external coat which covers the upper, posterior, and lateral sides of the bladder, is the true lamina or membrane of the peritonaeum; and the rest of it is surrounded by a cellular substance, by the intervention of which, the peritonaeum is connected to the muscular coat.

The proper coats are three in number; one muscular, one cellular, and an internal smooth one commonly called *villous coat*. The muscular coat is composed of several strata of fleshy fibres;

fibres; the outermoſt of which are moſtly longitudinal; the next to theſe are more inclined toward each ſide; and the innermoſt more and more oblique; and they become at length almoſt tranſverſe. All theſe fibres interſect each other in various manners; and they are connected together by a fine cellular ſubſtance, and may be ſeparated by inflating that ſubſtance.

Round the neck of the bladder the muſcular fibres are cloſely connected, and form what has been called *ſphincter veſicae*. But this part is not a diſtinct muſcle, nor is its action diſtinct from the reſt of the muſcular coat.

The cellular coat is nearly of the ſame ſtructure with what is called the *tunica nervoſa* of the ſtomach.

The internal coat is ſomething granulated and glandular, ſays Winſlow; but later anatomiſts deny the exiſtence of glands here. A mucilaginous ſerum is continually diſcharged through it, which moiſtens the inner ſurface of the bladder, and defends it againſt the acrimony of the urine. It appears ſometimes altogether uneven on the inner ſide, being full of eminences and irregular rugae when empty, and in its natural ſtate of contraction. Theſe inequalities diſappear when the bladder is full, or when it is artificially diſtended by air, or by injecting any liquid.

Urachus. At the top of the bladder above the ſymphyſis of the oſſa pubis, we obſerve a ligamentary rope, which runs up between the peritonaeum and the linea alba of the abdomen, all the way to the navel, diminiſhing gradually in thickneſs as it aſcends. This rope in the foetus is in part a production of the inner coats of the bladder, which production is termed *urachus*.

Arteriae umbilicales. This rope is compoſed likewiſe of two other ligamentary elongations, which are the extremities of the umbilical arteries. Theſe arteries come from the hypogaſtricae, run up by the ſides of the bladder, and remain hollow

low and filled with blood, even in adults, as high as the middle of the bladder, through all which ſpace they likewiſe ſend off ramifications. Afterwards they loſe their cavity, and become ligamentary as they aſcend. At the upper part of the bladder, they approach each other; and joining the urachus, form that rope, which may be termed the *ſuperior ligament of the bladder*.

The external fibres of the muſcular coat are more numerous than the internal; and the moſt longitudinal anterior fibres form a kind of incurvation round the urachus at the top of the bladder, much like that of one of the fleſhy portions which ſurround the ſuperior orifice of the ſtomach, and lower extremity of the oeſophagus. This incurvation paſſes behind the urachus.

The portion of the peritonaeum which covers the poſterior convex ſide of the bladder, forms a very prominent tranſverſe fold, when the bladder is contracted, which diſappears when the bladder is extended. This fold ſurrounds the poſterior half of the bladder, and its two extremities are elongated towards each ſide; by which elongations, a kind of lateral ligaments of the body of the bladder are formed, which are more conſiderable in children than in adults. Beſides theſe, the bladder has two other ligaments, which are fixed at their fore part to the upper and inner ſide of the oſſa pubis, near the ſymphyſis of theſe two bones; from whence they run back, becoming gradually broader, to be fixed to the ſides of the bladder. Sabatier calls them the *inferior anterior ligaments of the bladder*.

The lower part of the bladder, which deſerves the name of *fundus* much better than the upper part, is perforated by three openings, one anterior, and two poſterior. The anterior opening is formed by an elongation of all the proper coats, in form of a gullet, turned much in the ſame manner with the inner orifice of the roſtrum of the head of an alembic.

bic. This elongation is called the *neck of the bladder*, the deſcription of which belongs to that of the parts of generation in men.

The other two openings in the true fundus of the bladder are formed by the ureters, which in their courſe downward, already deſcribed, run behind the ſpermatic veſſels, and then behind the lower part of the bladder, approaching each other. Each ureter lies between the umbilical artery and vas deferens of the ſame ſide; the artery lying on the outſide of the ureter, and the vas deferens on the inſide.

Afterwards they get between the vaſa deferentia and the bladder, croſſing theſe canals; and then, at about a finger's breadth from each other, they begin to pierce the coats of the bladder. They run a little way between the muſcular and nervous coats, and open into the bladder obliquely, ſome thing nearer each other than when they firſt entered the coats.

The orifices of the ureters in the bladder are ſomething oval, and narrower than the cavity of the ureters immediately above them. The edge of theſe orifices is very thin, and ſeems to be formed merely by the union of the internal coat of the bladder with that of the ureters.

Blood veſſels and nerves of the bladder. The arteries of the bladder are furniſhed by the hypogaſtricae or iliacae internae, being rami of the arteria ſciatica, epigaſtrica, and umbilicalis on each ſide. The veins return to the internal iliac veins.

The nerves of the bladder come from the crurales, and alſo from the ſympathetici maximi, by means of their communication with the crurales. It has likewiſe ſome nerves from the plexus meſentericus inferior.

Beſides the ligaments already mentioned, there are likewiſe two ſmall ones, by which the anterior part of the true fundus of the bladder is connected to the oſſa pubis, which ſhall be deſcribed with the neck and ſphincter, after the hiſtory

tory of the parts of generation in both ſexes; and we refer to the ſame place, all that relates to the connection of the bladder with the other neighbouring parts.

§ 2. *Secretion of Urine.*

The chyle, when it enters the blood, contains a very large portion of water, which would be liable to lodge in the cellular ſubſtance, if it was not expelled again from the body. A part of it is therefore exhaled through the ſkin; and another part, as large, or often larger than the former, is ſtrained through the kidneys, and is thus expelled out of the body.

Dr Haller obſerved, "that the blood of the renal artery moving ſlower, as is generally believed, than that of the brain, and probably ſtored with more water, brought by the ſerpentine circles of the arteries, depoſites great part of its water into the rectilineal tubes of the papillae. This water contains fine oils and ſalts, intermixed with earthy particles, or ſuch other matters as are thin enough to paſs through with it. The ſmall diameter of the origin of each uriniferous duct, and its firm reſiſtance, ſeems to exclude the thick oil, chyle, and the coagulable lymph; but, as theſe uriniferous ducts are always open, if the velocity of the blood be encreaſed, or a morbid laxity of the parts ſupervenes, they eaſily tranſmit the above mentioned thick parts of the blood along with the thinner. The diſeaſe hence ariſing, is called diabetes, which may be cured by reſtoring the kidneys to their former healthy ſtate, by the uſe of aſtringents and tonics. The nerves have ſome power of contracting or relaxing theſe paſſages; and thus we ſee that urine, which, in health, is of a yellow colour, becomes watery from ſudden grief. A vaſt quantity of it is prepared; equal to that of perſpiration, and ſometimes even more." Later phyſiolo-

gifts explain the ſecretion of urine by obſerving, that part of the blood is changed by the kidney into this fluid.

The urine, by fire or putrefaction, ſometimes by diſeaſe, in ſome animals more eaſily than in others, changes into a volatile alkaline nature, intimately mixed with a fetid oil. This oil, which is partly empyreumatic, yellow, volatile, tenacious, ſeparable only by the greateſt degrees of fire, is known by the denomination of phoſphorus; it is a ſhining ſubſtance, taking fire ſpontaneouſly in the air. The urine abounds more with earth than any other juice of the human body, both of a cretaceous and ſparry nature; the latter coming chiefly from the drink, the former from the ſolid parts of the body diſſolved and mixed with the blood. There is alſo a conſiderable proportion of ſea-ſalt in freſh urine; from which it is even ſeparable after a long putrefaction, in the making of phoſphorus; in which proceſs a very great part of the urine is changed into volatile alkali. Nor is the urine, both of men and brutes, wholly deſtitute of a vitriolic acid, or at leaſt a ſimilar acid. There is likewiſe in the freſh urine a fuſible cooling ſalt, ſimilar to nitre. In fevers, the oily and ſaline parts of the urine are greatly augmented, both in quantity and acrimony.

That the urine is ſeparated in the kidneys is ſhewn experimentally, by preſſing it out of their veſſels. That it deſcends by the ureters is ſhewn by the ſurpriſing ſwelling of the kidney, and that part of the ureter which is above, as well as the emptineſs of that part which is below the ligature. In the bladder alſo, as well as in the kidneys and ureters, there is an immenſe ſwelling, as often as the bladder cannot receive the urine, or cannot emit it.

Nor does there ſeem to be any other way for the urine to paſs. For, although it is certain that the ſtomach, like all other membranes, exhales a moiſture through its coats; though it is not improbable, from experiments, that the bladder alſo abſorbs;

abſorbs; and, although the paſſage of mineral Spaw waters, by urine, be extremely quick, yet it does not thence follow, that there muſt be ways, different from that of the ureters, to convey the water from the food to the bladder. For the bladder is, on all ſides, ſeparated from the cavity of the abdomen by the peritonaeum; nor is it probable that the vapours, which either go out from the bladder, or which are derived towards it from other parts, can here find open pores through the peritonaeum. Beſides, membranes, when wet, have their pores filled, and conſequently are leſs adapted for imbibing either vapours or fluids. The bladder may be ſo diſtended with urine as to produce death; yet, in theſe caſes, we never obſerve that the urine has found any paſſage through which it might eſcape into the pelvis. Again, when the ureters are obſtructed with ſtones, ſo that the bladder receives nothing from them, it is either quite empty, or contains a very acrimonious and thick urine, manifeſtly indicating that the water can find no other way from the kidney into the bladder. And a careful attention to the manner in which mineral waters are diſcharged by urine, ſufficiently demonſtrates that there is no ſuch rapidity therein as is commonly imagined; but the ſtimulus of the cold water received into the ſtomach, like the external cold applied to the ſkin, cauſes a concuſſion of the bladder and urinary parts, by which they are ſolicited to repeated diſcharges of the old urine which was before in the body, and not immediately of that which was laſt drank. Again, the largeneſs of the renal veſſels demonſtrates, that they cannot receive much leſs than an eight part of the blood of the whole body at a time, and conſequently above 1000 ounces of blood are conveyed through the kidneys in an hour; and it will appear but a moderate allowance for 20 or even 50 ounces of water to diſtil from that quantity of blood in the ſame time. Finally, it is certain that both men and brute animals periſh if the ureters are obſtructed by a ligature, or otherways; we then obſerve alſo that no urine can be found in the bladder.

Experience

Experience aſſures us that the urine flows into the bladder in a continued ſtream: By ſtaying ſome time in the bladder, and from the abſorption of the more watery part, the urine acquires an higher colour, and becomes ſharper. We are not fully acquainted with the cauſe which retains the urine in the bladder. The ſphincter is obſcure; the ſituation of the bladder lying on the rectum may probably contribute to the retention of the urine. Certain it is that the urine does not flow ſpontaneouſly, even from a dead carcaſe.

At length, by the bulk and acrimony of the urine irritating the ſenſible fabric of the bladder, it is thence expelled, partly by the motion of the diaphragm and abdominal muſcles, preſſing the inteſtines againſt the bladder, by which means, eſpecially in an erect poſture, the urine makes itſelf a way through the narrow and impeded paſſage; and partly by the periſtaltic motion of the bladder itſelf, ariſing from the contraction of its muſcular fibres.

By the urine, beſides the particles of food and water, much matter that is noxious to the human body ſeems to paſs off, eſpecially calcareous earth reſorbed from the bones and ſolid parts, and which would not fail to produce bony cruſts and calculi wherever it was ſtopped; a ſparry or gypſeous earth; and an acrid oil mixed with ſalt, ſo as to aſſume a volatile nature. The urine, by its retention, diſpoſes to the generation of the ſtone and gout; when ſuppreſſed, it produces acute fevers, and ſeveral morbid affections of the brain.

§ 3. *The Parts of Generation in Males.*

Situation in general, and diviſion of theſe parts. The parts of generation in males are of different kinds, ſome of them being wholly contained in the abdomen, and others lying without it,

it. From this ſituation, they might properly enough be divided into external and internal parts; and all thoſe belonging to the firſt claſs might be deſcribed before thoſe of the ſecond.

But, as it is ſtill more proper to have a regard to the œconomy of theſe parts, according to which their functions begin in ſome internal parts, are continued in ſome external parts, return again to the internal, and are finiſhed in the external; we ſhall follow the ſame order in deſcribing them.

The firſt of theſe four claſſes comprehends the ſpermatic veins and arteries; the ſecond, the teſtes, epidydimis, and ſcrotum; the third, the vaſa deferentia, veſiculae ſeminales, and proſtates; and the fourth, the corpora cavernoſa, urethra, integuments, &c.

Scrotum. The ſcrotum is the cutaneous covering of the teſtes. Outwardly, it is a bag common to both, formed by a continuation of the ſkin of the neighbouring parts, and commonly very uneven, having a great number of rugae on its outer ſurface. Interiorly, it is fleſhy, and forms a muſcular capſula for each teſticle, termed *dartos*.

The exterior or cutaneous portion of the ſcrotum is nearly of the ſame ſtructure with the ſkin in general, of which it is a continuation; only it is ſomething finer; and it is likewiſe plentifully ſtored with ſebaceous glands and bulbs of roots of hairs.

Though it is a common covering for both teſticles, it is nevertheleſs diſtinguiſhed into two lateral parts by a ſuperficial and uneven prominent line, which appears like a kind of future, and from thence has been termed *raphe*.

This line is a continuatiou of that which divides, in the ſame manner, the cutaneous covering of the penis; and it is continued through the perinaeum, which it divides likewiſe all the way to the anus. It is only ſuperficial, and does not appear on the inſide of the ſkin.

The

The inner furface of this cutaneous bag is lined by a very thin cellular membrane, through which the bulbs and glands appear very diſtinctly when we view its inſide. The rugae of the ſcrotum are in the natural ſtate commonly a mark of health, and then its ſize is not very large. It increaſes in ſize, chiefly according to its length; and then the rugae diſappear more or leſs, according to the degrees of the preternatural ſtate or indiſpoſition.

The dartos of the ſcrotum has been accounted a true cutaneous muſcle; but it is chiefly a cellular ſubſtance condenſed, with a great number of blood-veſſels entering into its compoſition, but without fat. This ſubſtance is thin, and by the diſpoſition of its fibres, forms a bag with two cavities, or two ſmall bags joined laterally to each other, and contained within the cutaneous portion.

The lateral parts of theſe two bags, which are turned from each other, are longer than thoſe which are joined together; and by this union a ſeptum is formed between the teſtes, which may be called *mediaſtinum ſcroti*.

The raphe or ſuture already mentioned, adheres to the edge of this ſeptum, and thereby braces down the middle of the cutaneous portion, which from thence appears to have in part two cavities; and this was perhaps what gave occaſion to make the French word for the ſcrotum to be in the plural number. The other edge of the ſeptum adheres to the urethra.

The dartos has a ſtrict connection with the reſt of the cellular ſubſtance, eſpecially at the upper part below the groin, where its anterior and external lateral portions terminate by a kind of tendinous or ligamentary expanſion, which is ſtrongly united to the internal cellular membrane. We have often ſhewn this as a particular faſcia lata, which gives inſertion to the portions of the dartos juſt mentioned, and as a broad fraenum which keeps the ſame portions together.

The

The aponeurotic or ligamentary expanſion of the dartos is fixed in the ramus of the os pubis, between the muſculus triceps and the origin of the corpus cavernoſum of the ſame ſide, which ſhall be deſcribed hereafter, all the way to the lower part of the ſymphyſis of theſe bones. The internal portion of theſe muſcular bags, or that which forms the ſeptum ſcroti, is fixed to the urethra by means of a communication between the ſame ligamentary expanſion, and another, which ſhall be explained in its proper place.

Coats of the teſtes. The particular coverings of the teſtes are commonly called *coats;* and they are reckoned to be three in number, the tunica muſculoſa, named *cremaſter*, vaginalis, and albuginea. The firſt two are common to each teſticle, and to the ſpermatic rope that belongs to it; and the third is peculiar to the teſticle alone.

The tunica vaginalis is the moſt conſiderable of the three, and muſt be deſcribed firſt, in order to conceive the ſtructure and connection of the cremaſter, which is very improperly called a *coat.* The albuginea ſhall be deſcribed with the teſtes.

The tunica vaginalis is a continuation of the vagina of the ſpermatic rope, which, as it approaches the teſticle, is gradually dilated, and forms two capſulae, one contained within the other, the external being the longeſt and broadeſt at bottom; ſo that there is a void ſpace there left between them, in which the teſticle is lodged.

This ſtructure may likewiſe be explained in the following manner: The vagina having reached as low as the teſticle, is divided into two laminae, the innermoſt of which is the bottom of the vagina, and the outermoſt is expanded round the teſticle, and gives it a coat, called *vaginalis*, from the Latin word *vagina.* The antients termed it likewiſe *clytroides* from a Greek word that ſignifies the ſame thing.

The

The inner ſurface of this coat is lined by a fine membrane, which ſtrengthens the bottom of the vagina, and forms a kind of diaphragm, which prevents all communication between the vagina of the ſpermatic rope, and the tunica vaginalis of the teſticle.

Cremaſter. The cremaſter, improperly termed *a coat*, is a thin muſcle or fleſhy plane, which runs down round the vagina of the ſpermatic rope, and terminates in the tunica vaginalis of the teſticle.

It ſurrounds almoſt the whole vagina, and afterwards expands itſelf on the upper and external part of the tunica vaginalis, in which it is inſerted and loſt.

It ariſes partly from the ligamentum Fallopii, but chiefly from the lower edge of the internal oblique muſcle of the abdomen.

It is covered by a very fine cellular membrane, detached from the outſide of the aponeuroſis of the obliquus externus, round the opening commonly called the *ring*. This membrane is loſt in the cellular ſubſtance of the inſide of the dartos.

From all this we ſee, that the cremaſter is rather a tuſcle of the tunica vaginalis than a particular coat. Thoſe among the antients who believed it to be a coat, called it *tunica erythroides*, from a Greek word which ſignifies *red*; but this muſcle is not always red, neither is that colour eſſentially neceſſary to a fleſhy ſubſtance.

Teſtes. The teſtes are two glandular bodies, ſituated near each other, without the abdomen, below the interſtice between the groins in an adult. The antients named them *didyni* or *gemini*. Their ſize is nearly that of a pigeon's egg, and they are of an oval figure, a little flated at each ſide. But they are frequently unequal in ſize in the ſame perſon. Fabricius ab Aquapendente, was conſulted frequently by perſons who believed they had got a diſeaſed teſticle, becauſe it was larger than

than the other one; but, upon examination, it was found they had no inconvenience from it. We may conſider in each teſticle two extremities, two edges, and two ſides. One extremity is ſituated forward and a little upward, the other backward, and a little downward; and their edges lie upward and downward.

At the upper edge they have each an appendix, called *epidydimis*, together with which it is involved in ſeveral coverings; and they are both ſuſpended in the common covering, called the *ſcrotum*.

Each teſticle is a ſpermatic gland formed by a vaſt number of fine whitiſh tubes, folded and twiſted in different manners, and diſtributed in different faſciculi, between membranous ſepta; the whole being ſurrounded by a ſtrong common covering, named *tunica albuginea*.

Theſe ſepta are diſpoſed longitudinally, divaricating from each other on one ſide, and approaching on the other. They approach each other along one edge of the teſticle, and terminate in a long narrow whitiſh body, as in a kind of axis.

From thence they divaricate in a regular manner, and are fixed by their oppoſite edges in the inner ſurface of the tunica albuginea, of which they appear to be a continuation. This white body may be termed the *nucleus* of the teſticle, or by ſome has got the name of *corpus Highmorianum*.

From this deſcription we ſee, that all theſe ſepta are not of an equal breadth; that the interſtices between them are in ſome meaſure triangular; and that the extent of the ſmall tubes, which lie therein, muſt be very conſiderable. They have been reckoned to amount to many yards, by taking the ſum of all their ſeveral portions; and they may be eaſily unfolded by a long maceration, which deſtroys the delicate ſubſtance by which all their folds and convolutions are connected and tied down.

The ſeminal veſſels are ſerpentine, firm, ſolid, and exceedingly ſmall; they have been filled with quickſilver, &c. by ſeveral anatomiſts, and firſt by Dr Monro, Hunter, and Haller. They are collected into above twenty bundles, divided by diſtinct cells or partitions, which deſcend from the tunica albuginea to conduct the arteries or veins. In each of theſe cells there is a ſeminiferous duct to convey the ſecreted humour from the teſticle. The ducts form a net-work, adhering to the ſurface of the albuginea, and forming inoſculations one with another. From this net-work, in the upper part of the teſticle, ten or twelve ducts aſcend; which being contorted together into folds, form as many vaſcular cones, that are joined together by an intermediate cellular ſubſtance; and, lying incumbent one upon another, there form the

Epidydimis, which goes round the outer and poſterior margin of the teſticle, to which it adheres by its thicker head, joined with a good deal of cellular ſubſtance: While in its lower, middle, and more ſlender part, it partly adheres, and is partly free; ſo as to intercept a ſort of impervious bag between itſelf and the teſticle. The vaſcular cones, at the upper part of the epidydimis, by degrees uniting, form at length one duct, which compoſes the greater part of the teſticle (*ſee* Monro de Teſtibus), and which grows larger as it deſcends, being largeſt at the bottom of the teſticle; from whence again aſcending along the poſterior face of the teſticle, in a contrary direction, it by degrees ſpreads open its ſpiral convolutions, and comes out much larger, under the name of *vas deferens*.

The epidydimis thus formed, may be reckoned a production of the teſticle, or a kind of teſtis acceſſorius; and it reſembles in ſome meaſure an arch ſupported by its centre or frame. It is more contracted at the middle than at the extremities, by which it is cloſely united to thoſe of the teſticle.

Between

Between its extremities it does not immediately touch the teſticle; but is only looſely connected to it by the duplicature of a very fine and almoſt tranſparent membrane, as by a kind of ligament. This membrane is the continuation and duplicature of the tunica albuginea, or proper coat of the teſticle; which having ſupplied the place of a ligament to the epidydimis, afterwards inveſts it.

The epidydimis is flat, a little concave on the under ſide or that next the teſticle, irregularly convex on the upper ſide or that turned from the teſticle: And theſe two ſides are diſtinguiſhed by two angular edges; by the innermoſt of which it is connected to the teſticle in the manner already ſaid, but the outer edge and flat ſide are looſe and free.

Beſides the ducts commonly deſcribed in the epidydimis, late anatomiſts have ſometimes found a duct going off from the epidydimis; but its termination was not well underſtood. It was ſuppoſed to terminate in the lymphatic ſyſtem; in a few ſubjects Dr Monro has found ſuch a duct ariſing from one end of the epidydimis and running into the other end.

By this deſcription of the extremities and edges of the epidydimis, Winſlow demonſtrated, many years ago, a method to diſcover whether a teſticle, viewed extra ſitum, belongs to the right or left ſide.

The ſpermatic veſſels. The ſpermatic arteries go out moſt commonly from the anterior part of the inferior aorta, near each other, and about an inch lower than the arteriæ renales. Their origin oftentimes varies; for I have obſerved them to ariſe from the renal artery; and ſometimes they go out higher, lower, or more laterally than is common, and each artery has been ſeen to ariſe from different places. Sometimes there are two on each ſide, one ariſing a little below the other; or at other times one comes from the aorta, the other from the renal artery on the ſame ſide; and here they give off branches to the cremaſter muſcle, &c.

They

They run down obliquely in the poſterior part of the abdomen within the cellular ſubſtance of the peritonaeum, paſſing inſenſibly from behind forward; and ſo parting gradually more and more from the aorta, they croſs over the foreſide of the ureters, and run through the openings or rings of the abdominal muſcles along with the elongations or productions of the cellular portion of the peritonaeum.

They are ſmall at their origin; and, in their courſe downward, they give off very conſiderable lateral ramifications to the membrana adipoſa, peritonaeum, and alſo to the menſentery, where they ſeem to communicate with the meſenteric arteries. After producing numerous branches to theſe parts their ſize is not diminiſhed; ſometimes, on the contrary, it is much increaſed, owing ſeemingly to the arteries, which are very long, and their coats thin, not being ſufficiently able to reſiſt the preſſure of the blood.

They ſometimes paſs through the areolae or meſhes of the ſpermatic veins; and before they go out of the abdomen, they are divided into very fine rami, which run in a more or leſs winding courſe, almoſt parallel to each other.

Afterwards they enter the cellular productions of the peritonaeum, which ſerve them for vaginae. They do not fluctuate indifferently from one ſide to the other of theſe vaginae; but are connected along their inner ſurface by thin membranous laminae, which are likewiſe continuations of the cellular ſubſtance of the peritonaeum.

The arteries continue the ſame winding courſe within theſe vaginae, paſſing before the vaſa deferentia, which are likewiſe contained in the vaginae; and at length they terminate by ramifications in the epidydimis and teſtes, in the manner that ſhall be afterwards explained.

The ſpermatic veins accompany the arteries, and have nearly the ſame courſe. The right vein ends commonly in the trunk of the vena cava, and ſometimes it ends in the union of the right

right renal vein with the vena cava, and ſometimes three veins on the right ſide end ſeparately in the trunk of the vena cava. The left ſpermatic vein ends moſt commonly in the vena renalis ſiniſtra.

After getting into the abdomen they receive a branch which communicates with the vena meſeraica, and conſequently with the vena porta. A little higher, but below the place where they croſs over the ureters, they receive a conſiderable branch, one of which communicates with the vena capſularis, the other frequently with the vena renalis; and in their whole courſe through the abdomen, they receive branches from the peritonæum, meſentery, &c.

They differ from the ſpermatic arteries, not only in being larger, and having thinner coats, but alſo in being more divided and multiplied in the abdominal muſcles; and as they are formed of a large faſciculus of ramifications, the antients gave to them, and to the arteries, the name of *vaſa pyramidalia*.

Theſe ramifications often communicate with each other in this courſe, and form a great number of areolae, contortions, and convolutions, ſo as to repreſent a kind of plexus, which is connected to the cellular vagina of each ſide by very fine laminae; and the artery which accompanies the vein croſſes it in ſeveral places, and runs through the areolae in different directions. Theſe frequent convolutions gave riſe to the name of *vaſa pampiniformia*, formerly given to theſe veſſels; and their particular adheſions to each other at ſome places, made it be believed that there were real anaſtomoſes between the artery and the vein.

Leal Lealis an Italian anatomiſt, not attending to the lateral ramifications of the ſpermatic arteries and veins, believed himſelf able to eſtabliſh and demonſtrate theſe pretended anaſtomoſes. The experiments made by him on living animals prove nothing. His way was, to make a common ligature on both veſſels

veſſels a little above the teſticle, and another on the trunk of the vein, after he had emptied it. Then preſſing the aorta to force the blood into the ſpermatic artery, the vein which he had before emptied was found to be preſently filled.

From thence he concluded, that the courſe of the blood to and from the teſticle being obſtructed by the inferior ligature, there muſt be ſome anaſtomoſes between the two ligatures, through which the vein muſt be ſupplied with blood. But it is very plain, that this effect was owing to the lateral ramifications of the ſpermatic artery and vein, and not to his pretended anaſtomoſes. Theſe fine lateral ramifications were well known to Euſtachius, but had eſcaped Leal Lealis.

Vaſa deferentia. The vaſa deferentia are two white ſolid flatted tubes; one lying on the right ſide, the other on the left. From the epidydimis, of which they are continuations, as has been already ſaid, each of them runs up in the cellular vagina of the ſpermatic veſſels, as high as the openings in the abdominal muſcles; the blood-veſſels, lying forward, and the vas deferens behind them.

This faſciculus thus formed, by the blood-veſſels, vas deferens, and their common covering, is termed the *ſpermatic rope.* The covering is ſmoother on the outer than on the inner ſide; and for that reaſon it has been conſidered as a vagina; the internal ſubſtance of which is moſtly cellular, and connects all the veſſels together, while the external forms a covering to inveſt them.

The vas deferens having reached the membranous lamina of the peritonaeum, where that lamina runs over the orifice of the vagina, ſeparates from the blood-veſſels, and runs backward, in form of an arch, in the cellular ſubſtance of the peritonaeum, as far as the neareſt ſide of the bladder.

It paſſes afterwards behind the body of the bladder, to which it adheres very cloſely, as alſo to the lamina of the peritonaeum which

which covers it, and then continues its arched courſe towards the neck of the bladder, where both vaſa deferentia meet, and their arches terminate.

In this courſe, the vas deferens paſſes behind and croſſes the neighbouring umbilical artery; croſſes the extremity of the ureter of the ſame ſide, in its paſſage between the extremity and the bladder; and having got behind the bladder, it meets the vas deferens of the other ſide between the inſertions of the ureters, and they run down together to the neck of the bladder.

This canal, which at the origin of the epidydimis is large and plaited, becomes immediately afterwards ſmaller and ſmoother, and continues in that form till it gets behind the bladder, where it begins again to be larger, and more uneven.

It ariſes from the angular portion or poſterior extremity of the epidydimis; and from thence runs forwards in a very oblique courſe, on the poſterior half of the epidydimis, where it is a little incurvated as it joins the back-ſide of the ſpermatic veſſels.

The texture of the ſmooth portion of this canal is very ſolid, and in a manner cartilaginous, eſpecially near the ſurface of its cavity; which, though very narrow, is ſtill kept open by means of the ſolidity and thickneſs of its ſides.

The cavity of the vas deferens is cylindrical, though the whole tube is flat, and its external circumference oval, as may be ſeen by cutting it tranſverſely; and the cavity enlarges as it paſſes behind the bladder. The termination of theſe canals muſt be referred to the hiſtory of the urethra.

Veſiculae ſeminales. The veſiculae ſeminales are ſoft whitiſh knotted bodies, about three or four fingers breadth in length, one in breadth, and about three times as broad as thick, ſituated obliquely between the rectum and lower part of the bladder, in ſuch a manner, as that their ſuperior extremities are at a diſtance

tance from each other, and their lower extremities are contiguous.

They are irregularly round on the upper part, and their breadth decreaſes gradually from thence. By the union of their lower extremities they form a kind of fork, the branches of which are broad, and bent like rams horns. Theſe extremities are very narrow, and form a ſmall neck, which runs behind the bladder toward its orifice, and continues its courſe in the groove of the proſtrates, through the ſubſtance of the contiguous portion of the urethra, till its extremities pierce the caruncula in the manner alreadý ſaid.

The inner ſubſtance of the veſiculae is plaited, and in a manner diſtinguiſhed into ſeveral capſulae by contorted folds. Their external ſurface is covered by a fine membrane, which ſerves for a border and fraenum to the folds, and is a true continuation of the cellular ſubſtance of the peritonaeum. The veſiculae may eaſily be unfolded, and all their contortions ſtraightened; and by this means they become much longer than in their natural ſtate.

Their inner ſurface is villous and glandular, and ſomething ſimilar to the inner ſurface of the gall-bladder, or like the cells of a honey-comb. This furniſhes a particular fluid, which exalts, refines, and perfects the ſemen, that the veſiculae receive from the vaſa deferentia, and of which they are the reſervatories for a certain time.

The paſſage of the vaſa deferentia into the veſiculae is very particular. We have already obſerved that theſe canals are incurvated behind the bladder, and that their contracted extremities unite at that place. They unite in an angle, and run between the contiguous extremities of the veſiculae; and this union is ſo cloſe, that the adhering portion ſeems to form only one middle ſeptum, between two ſmall tubes; each of which is formed, partly by the extremity of one vas deferens, and partly by that of the neighbouring veſicula.

This

This lateral union of the extremities of the vas deferens, and veſicula ſeminalis on each ſide, forms likewiſe a kind of ſhort ſeptum, which terminates in a crescent, like a ſmall ſemilunar valve; and the extremity of the vas deferens is narrower than that of the veſicula. By this mechaniſm, the fluid contained in each vas deferens has liberty to enter the contiguous veſicula; but that contained in the veſicula cannot return into the other canal.

If we blow into one of the vaſa deferentia, after having compreſſed the urethra, the air inflates the contiguous veſicula ſeminalis and the bladder of urine, without paſſing into the veſicula or canal of the other ſide; except we blow with two great violence.

Afterwards the two ſmall tubes, formed each by the extremities of the vas deferens and veſicula, run in between the baſis of the proſtates and canal of the urethra; and perforating the ſides of that canal obliquely, they terminate in the caruncula, in the manner already ſaid. That of the right has no communication with that of the left.

The veſicula ſeminales receive their blood-veſſels from thoſe which ſupply the rectum and bladder. They have lymphatic veſſels which carry off the thinneſt part of the ſemen into the circulating ſyſtem.

Proſtatae. The firſt portion of the urethra, or that which is not covered by the cavernous ſubſtance, and which, from the bladder to the bulb, is only a membranous canal, is ſuſtained by a large ſolid whitiſh maſs, of the figure of a cheſnut, and ſituated between the bladder and the bulb of the urethra; its baſis being toward the bladder, the apex or point toward the urethra, and the ſides lying upward and downward.

This body is termed the *proſtates*, from a Greek word that expreſſes its ſituation before the veſiculae ſeminales, and implies a plurality, becauſe it appears to be divided into two

lateral lobes by a hollow groove, which runs through its upper ſide from the baſis to the apex. The firſt portion of the urethra lies in this groove, adhering very cloſely to the proſtates, which ſurround it for about half an inch in length; but there is only a very ſmall part of the proſtate upon the fore-ſide of this paſſage.

The body of the proſtates lies on the inteſtinum rectum, and the apex is under the internal labium of the cartilaginous arch of the oſſa pubis. The inner ſubſtance is ſpongy, but very compact; and in each lobe there are ſeveral folliculi, which open into the firſt portion of the urethra, toward the bottom of the groove, as we ſhall ſee hereafter. The ſmall portion of the urethra, between the apex of the proſtates and the bulb, perforates a ligamentary ſubſtance, which is ſituated at the under and back part of the ſymphyſis pubis. This portion is very ſhort, its length being no more than what is ſufficient to paſs through the hole in the ligament; the poſterior ſide of which conſequently touches the apex of the proſtates, and its foreſide the bulb of the urethra. This portion might be called the *neck* of the urethra, and that which lies between the body of the bladder and the proſtates might be called the *neck* of the bladder.

Glans. The ſpongy ſubſtance of the urethra having reached the extremity of the corpora cavernoſa, forms a large head called the *glans*, which crowns the three ſpongy pillars; with this difference, however, that it is a continuation of the ſpongy ſubſtance of the urethra, and only adheres to the extremity of the corpora cavernoſa, without any direct communication.

It is for this reaſon, that if we blow into the ſpongy ſubſtance of the urethra, the glans is preſently inflated, and no air paſſes into the corpora cavernoſa; but when we blow into one of theſe bodies, the air paſſes immediately into the other, the urethra and glans remaining as they were.

The

The figure of the glans is that of a rounded cone, a little flattened at the lower part, and with an oblique prominent baſis, the circumference of which is ſomething greater than that of the corpora cavernoſa.

The ſpongy ſubſtance of the glans is thick and uniform next the corpora cavernoſa; but next the urethra it is perforated by a continuation of that canal, and is there no thicker than the urethra before the formation of the glans.

Therefore the canal of the urethra does not lie in the middle of the glans, but continues its direct courſe through the lower flat ſide of it, all the way to the extremity, where it terminates by an oblong orifice.

All the convex ſurface of the glans is covered by a fine villous ſubſtance, and that again by a fine membrane, reſembling the red part of the lips. The circumference of the baſis of the glans has a double row of ſmall papillae, which may be reckoned ſebaceous glands, from which a thick matter is diſcharged.

Caruncula. We have ſeveral things to take notice of in the cavity of the urethra. At the bottom of the cavity of the firſt portion, or that which lies within the proſtates, there is a ſmall oblong oval eminence, large on the back part, and terminating forward in a point, called *caruncula* or *veru-montanum.* The large portion of it is commonly perforated by two holes, ſometimes only by one, and very ſeldom by three; and theſe are the excretory orifices of the veſiculae ſeminales; of which hereafter. Each orifice has a ſmall thin membranous border, which may ſerve for valves to the excretory ducts of the veſiculae.

On each ſide of the large portion of the caruncula, there are five or ſix holes ranked in form of a creſcent round its lateral parts, which are the orifices of the excretory ducts of the proſtates that come from the folliculi already mentioned, and

and run in an oblique courſe to the orifices, in a kind of membranous duplicature.

Corpora cavernoſa. The corpora cavernoſa are two ligamentary and very limber tubes, united laterally to each other through the greateſt part of their length, and ſolid at their two extremities; two of which are connected together, and rounded like the end of a finger; the other two divaricate like the branches of the Greek Υ; and diminiſhing gradually in ſize after the divarication, terminate in an oblique point. Theſe divaricated and pointed extremities may be called the *roots*, and the round extremities the *heads*.

Theſe two bodies are almoſt cylindrical, being round, and of an equal diameter from the roots to the heads, where they are in ſome meaſure conical. The ligamentary ſubſtance of their ſides is claſtic, and compoſed of fine cloſe fibres, which are partly tranſverſe, and partly more or leſs oblique.

The cavity of theſe ligamentary tubes is entirely filled by ſtrong cellular or cavernous ſubſtance, which does not ſeem to be a continuation of the ſubſtance of the ſides. Theſe cells communicate with each other; and are always more or leſs full of blood, reſembling very much the cellular ſubſtance of the ſpleen, only with this difference, that the ſides of the cells are thicker in theſe cavernous bodies, and without any additional ſubſtance.

By the union of the two corpora cavernoſa, two external grooves are formed; one on the upper ſide, the other on the lower. The lower groove is ſomething broader than the upper; and it is filled through its whole length by a third tube narrower than the corpora cavernoſa, called the *urethra*; which ſhall be preſently deſcribed.

The roots of the corpora cavernoſa are fixed, each to the edge of the ſmall ramus of the iſchium and os pubis. They meet at the ſymphyſis of the oſſa pubis, where each of them

becomes

becomes a cylindrical tube, and unites with the other in the manner already ſaid.

The heads or rounded extremities join the baſis of a diſtinct body, called the *glans*, which is an expanſion of the urethra, and cloſely united to it in the manner that ſhall be explained hereafter.

By the union of the corpora cavernoſa from their roots to their round extremities or heads, a particular ſeptum is formed by the tranſverſe fibres of both. Between the fibres of this ſeptum ſeveral ſmall void ſpaces are left, by which the corpora cavernoſa communicate with each other; and therefore, by blowing into one of them, we preſently inflate the other. Toward the rounded extremities the ſeptum diminiſhes every way.

Urethra. The urethra is the third ſpongy tube which compoſes the penis; and it adheres to the corpora cavernoſa, through the whole length of the inferior groove formed by their union. It differs from the other two, both as it is narrower, and as it forms a true hollow canal. Its ſubſtance is ſpongy or cavernous, except a ſmall portion next the bladder; and its inner and outer ſurfaces are membranous. It extends from the neck of the bladder to the extremity of the penis.

It is at firſt no more than a membranous canal continued from the anterior opening of the bladder, at the place called the *neck* of the bladder, which is a name that would be more proper for this portion of the urethra. It deſcends from its origin to the under end of the ſymphyſis pubis; then it aſcends before the ſymphyſis to the root of the penis; and at laſt redeſcends to the point of the glans.

About a finger's breadth from this part, it joins a cavernous ſubſtance like that of the two other tubes, only ſmaller, which ſurrounds it through the whole extent of the inferior groove of the corpora cavernoſa.

But

But before this ſpongy ſubſtance begins to ſurround the urethra, it forms a diſtinct oblong body, like a pear, which is connected only to the lower convex ſide of the canal; and afterwards being ſplit on each ſide, inveſts it quite round. This body is called the *bulb* of the urethra, being larger than any other part of that canal, and divided interiorly by a very fine membranous ſeptum into two lateral parts; and therefore, when it is inflated, it appears to be double, or with two heads.

Lacunae of the urethra. The inſide of the canal of the urethra is lined by a fine membrane, full of capillary blood-veſſels; and its ſurface is perforated by a great number of oblong holes, or ſmall lacunae of different ſizes, the largeſt lying near the glans.

Theſe lacunae or orifices of the excretory ducts of the ſame number of ſmall glands, are diſperſed through the ſubſtance of the urethra; which ducts run for ſome way in the ſpongy ſubſtance along the convex ſide of the internal membrane of the urethra, and open obliquely from behind forward into the great canal. The edges of the lacunae are ſemilunar, or like a creſcent, becauſe of the obliquity of their opening.

Anti-proſtatae. A little way before the veru-montanum, without the urethra, we meet with two lacunae more conſiderable than the reſt, and their ducts are very long. Theſe lacunae and ducts lead to two glandular bodies, ſituated, one on each ſide, between the poſterior and lateral parts of the muſculi acceleratores urinae, and the bulb of the urethra. Each of them is about the ſize of a garden pea; but they are oblong and flat, and covered entirely by the accelerator muſcles. They are known by the name of *proſtatae inferiores*; but if their ſituation be carefully examined, they will be found to be higher than the true proſtatae. They are likewiſe termed *glandulae mucoſae of Cowper*, who has given a deſcription of them (*ſee* Phil. Tranſ. 1699); but they were firſt deſcribed by Mery in 1684. They

ſeem

ſeem to be wanting in ſome ſubjects; for certain anatomiſts of accuracy have ſearched for them without finding them. A third gland of this kind is deſcribed by Cowper as being ſeated a little more anteriorly; but this alſo, Heiſter obſerves, is wanting in bodies diſſected by our beſt anatomiſts.

Orifice of the urethra. The cavity of the urethra reſembles nearly that of a ſmall writing pen. It is not every where round, and towards the glans becomes broader and flatter on each ſide, eſpecially in the glans itſelf, where there is a kind of oval or navicular foſſula.

This canal terminates at the extremity of the glans by a narrow oblong orifice or fiſſure, which is much leſs than the reſt of the cavity. The commiſſures of the ſmall fiſſure are turned, one toward the convex, the other toward the flat ſide of the glans; and the labia of the fiſſure are its lateral parts; and it ſeems to be ſurrounded by fleſhy fibres.

The common integuments. The integuments which cover all theſe parts are three or four in number. The firſt is the ſkin with the cuticula; the ſecond is the common cellular membrane, which in this place ſeldom contains any fat; the third is termed *nervous;* and the fourth is a particular cellular membrane, which is not always to be found.

Praeputium. The firſt of theſe integuments, the ſkin, is a continuation of that of the pubes and ſcrotum; and it adheres to the ſecond all the way to the baſis of the glans, where that ſecond integument ends. The reſt of the cutaneous integument covers the glans without adheſion, and terminates by an opening. This portion is named *praeputium*; and along the whole lower or back ſide of the whole integument in general, and of the praeputium in particular, there runs a fine ſuture which is a continuation of the raphe of the perinaeum and ſcrotum.

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The inner ſurface of the praeputium is lined with a fine membrane from the opening all the way behind the baſis of the glans, and the ſame membrane is folded from behind, forward, round the glans, forming the proper integument of it, and covering very cloſely its whole villous ſurface, as far as the orifice of the urethra, where it joins the membrane which lines the inſide of that canal.

This proper membrane of the glans, and internal membrane of the praeputium, form conjointly along the flat part of the glans, from its baſis to the orifice of the urethra, a membranous duplicature, which, like a ſeptum or mediaſtinum, divides this part into two lateral portions, and limits the motions of the praeputium; for which reaſon it is called *fraenum praeputii.*

The ſurface of the internal membrane of the praeputium diſcharges a fluid which prevents it from adhering to the glans, and perhaps ſerves likewiſe to dilute that which is collected at the baſis of the glans, from the glandulae ſebaceae, already mentioned.

The ſecond common integument of theſe parts is nearly the ſame with what is every where found under the ſkin, except that it is not filled with fat, and that it is more fibrous than cellular, and a little looſe. It accompanies the ſkin to the baſis of the glans, as has been already obſerved.

Ligamentum ſuſpenſorium. The third common integument, improperly called *tunica nervoſa*, is of a firm, elaſtic, ligamentary ſubſtance, and its fibres are ſometimes of a yellowiſh colour. It inveſts the corpora cavernoſa and urethra from the glans to the ſymphyſis of the oſſa pubis; and, at ſome diſtance from theſe bones, it forms on the ſuperior groove of the corpora cavernoſa a cloſe duplicature; and by this duplicature, a flat broad ligament which runs directly upward, and is inſerted in the forementioned ſymphyſis, as far as the tendinous baſis of the muſculi pyramidales of the abdomen.

This

This ligament hat been called *ligamentum elaſticum*, becauſe it yields and recovers itſelf; and *ſuſpenſorium*, becauſe it ſuſpends theſe parts, by means of its inſertion in the ſymphyſis. It ſends off a detachment or ala toward each ſide, one edge of which is fixed between the muſculus triceps and the corpus cavernoſum, and forms the ligamentary expanſion, in which the dartos is inſerted, as has been already ſaid. It ſeems likewiſe to ſend down another elongation directly to the perinaeum and anus.

The fourth integument of theſe parts is the tunica celluloſa of Mr Ruyſch, which immediately ſurrounds the corpora cavernoſa and urethra, lying between theſe and the third integument, from which it ſeems to be diſtinguiſhed only by the cloſeneſs and fineneſs of its texture; and it is ſometimes hardly perceivable.

The muſcles. Several muſcles are inſerted in the parts which we have juſt deſcribed. They are ſix in number; two for the corpora cavernoſa, two for the urethra, and two common muſcles, called *tranſverſales*. (See Vol. I.)

Blood veſſels. The arteries of theſe parts come chiefly from the iliacae internae or hypogaſtricae, and the reſt from the iliacae externae or crurales. The principal arteries are termed *pudicae*, of which one is external, the other internal.

The pudica externa ſends a branch to each ſide, which having paſſed out of the pelvis by the ſide of the os ſacrum, runs on the inſide of the tuberculum iſchii, to the roots of the corpora cavernoſa, along the inſide of the muſculi iſchio-cavernoſi or erectores. It ſends ramifications to the bulbous head of the urethra, and to the corpora cavernoſa; and, together with the glutaeae, with which it communicates in its paſſage, it likewiſe ſupplies the ſcrotum.

The pudica interna having furniſhed the inteſtinum rectum, bladder, veſiculae ſeminales, and proſtates, communicates with the haemorrhoidales, paſſes under the arch of the oſſa pubis,

and partly enters the corpora cavernoſa, and partly runs along their upper ſide, ſending off ſmall lateral branches, which ſurround theſe bodies, like irregular half arches, and penetrate them by numerous ramifications.

The crural arteries ſend each likewiſe a branch, which, running behind the contiguous crural vein, is diſtributed to the integuments of the penis, by the name of *pudica externa*, and communicates, by lateral ramifications, with thoſe of the pudica interna. Theſe communications are not only between the internal and external pudicae of the ſame ſide, but alſo between thoſe of both ſides, which reciprocally communicate with each other.

The diſtribution of the veins follows nearly that of the arteries; but they have more ramifications and communications, as in other places. The principal vein is that which runs along the whole ſuperior groove, formed by the union of the corpora cavernoſa. It paſſes directly under the ſymphyſis of the oſſa pubis, between the two arteries. It is very large, often double, and very ſeldom triple, but the trunks do not ſeparate while in the groove; and it has a great number of valves.

This great middle vein opens into the branches of both hypogaſtric veins. The lymphatic veſſels of the penis appear to go chiefly into the plexus in the groin, on the two inner ſides of the pelvis, about the middle of the arch of the oſſa pubis. At this place we obſerve a venal plexus, which covers the upper convex ſide of the firſt portion of the urethra, before it is ſurrounded by the ſpongy ſubſtance.

The ſpermatic veſſels, of which we have already deſcribed the origin and courſe all the way to where they go out of the abdomen, having reached on each ſide near the teſticle, are divided into two principal faſciculi, one of which is larger than the other. The largeſt is the anterior, and is diſtributed through the teſticle, by a prodigious number of very fine capillary ramifications,

mifications, which accompany all the convolutions and folds of the ſmall canals.

The other faſciculus is poſterior, and is diſtributed to the epidydimis in the ſame manner.

The ſpermatic artery is accompanied by a ramus of the epigaſtric artery, which runs down on the ſide of it as far as the teſticle, where they communicate reciprocally with each other. There is ſometimes a ſmall ramus of the hypogaſtric artery, which accompanies the vas deferens to the epidydimis, and there communicates with the arteria ſpermatica. The teſticle has likewiſe numerous lymphatic veſſels, which run in the ſpermatic cord, and join the lymphatics of the pelvis and loins.

Nerves. The nerves of theſe organs come from the lumbares and ſacri; and they communicate with the ſympatheticus maximus, and plexus meſenterici. Near the arch of the os pubis, they form together, on each ſide, a particular rope, which paſſes under that arch along the upper ſide of the neighbouring corpus cavernoſum, near the artery already mentioned.

In their paſſage over the corpora cavernoſa, they ſend off a great many rami, which ſurround theſe bodies on all ſides, between the ſkin and the ligamentary integument; being ſo diſpoſed, as that the arteries lie between them and the middle vein. They muſt be examined ſoon after the ſkin has been raiſed, becauſe, when the ramifications are dried by the air, they diſappear.

The nerves of the teſticles are very ſmall. They are formed by the renal and meſenteric plexus. The nerves of the loins ſend ſmall branches likewiſe along with theſe. They run along the ſpermatic cord; but it is exceedingly difficult to trace them into the teſticle.

There is likewiſe one nerve on each ſide; which being produced from the union of the ſecond, third, and fourth pairs of the

the nervi ſacri, eſpecially from the third, goes out of the abdomen above the ligamentum iſchio-ſacrum, paſſes by the inſide of the tuberoſity and ſmall branch of the os iſchium, and is diſtributed to the corpora cavernoſa, to the muſcles belonging to them, and to the neighbouring parts.

§ 4. *Secretion of the Semen.*

The veſſels belonging to the parts of generation conſtantly ariſe near the kidneys, almoſt in all kinds of animals; by which nature ſeems to have intended a double uſefulneſs in one organ, which might be able to diſcharge the urine : ſemen. The ſituation of the parts of generation at the lower part of the trunk, and between the thighs, conduces much to cleanlineſs and to facilitate parturition.

The ſemen maſculinum is firſt formed in the teſticle; then repoſited in the ſeminal veſicles; afterwards ejected from the penis into the uterus, where it renders the female ovum prolific; and therefore this muſt be the order of our inquiry into theſe particulars.

The teſticle is defended by various integuments, and is compoſed of various kinds of veſſels and of nerves, as have been already deſcribed.

The blood, brought by a very ſlow motion through the ſpermatic artery to the anterior ſubſtance of the teſticle, is there diſtributed and conveyed into the ſeminiferous veſſels; but we are ignorant of the manner by which the arteries communicate with theſe canals, the bundles of which form the whole ſubſtance of the teſticle. Theſe ſeminiferous veſſels are exceedingly ſmall, ſerpentine, firm, ſolid, and have a very ſmall capacity in proportion to their membranes. They are collected together, as has been deſcribed above, and terminate in the vaſa deferentia.

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The ſemen is conveyed by the vaſa deferentia into the veſiculae ſeminales, being propelled forward by the motion of the ſucceeding juices in the teſticle; and perhaps, in ſome meaſure, though ſlowly, by the contraction of the cremaſter. This ſuppoſition is confirmed by the numerous ſpires and convolutions formed by the epidydimis, obſtructing almoſt every kind of injection; and by the length of time that is required to fill the ſeminal veſicles again, after they have been once exhauſted.

The cylindric vas deferens, conſiſting of a very thick ſpongy ſubſtance, included between two firm membranes, aſcends in company with the cord of the ſpermatic veſſels, and together with them, paſſes through the ring of the abdomen: Thence it deſcends into the pelvis, and applying itſelf to the bladder between the ureters, it ſoon after meets the ſubjacent receptacles, called the right and left *veſiculae ſeminales*. Here it goes along the inner ſide of the veſicle, as far as the proſtate gland; and, dilating in its paſſage, forms a ſerpentine flexure, that begins to put on a cellular appearance. But very near the proſtate, being continued from theſe cellular bendings, with a conical duct coming out from the veſicle, it unites in a very acute angle, which at the ſame time forms a conical duct; which being continued with the vas deferens, and ſinking through the proſtate gland, is there wrinkled into a large fold, and going off outward at right angles from its companion on the other ſide, and afterwards ſtraightened, it opens into the urethra, through a little hollow protuberance, which has a long tail or deſcent, and is laterally perforated with two very ſmall openings, one on each ſide. By injecting liquor into the vas deferens of a dead ſubject, we perceive that it flows both into the urethra and into the ſeminal veſicle, but more readily into the former: But in a living perſon the ſemen never flows out but in the act of venery, and conſequently the vas deferens conveys all its ſemen, without further delay, in a retrograde angle, to the *ſeminal veſicles*.

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The liquor brought from the teſticles by the vaſa deferentia, is yellowiſh, thin, and watery; but in the veſicula ſeminales it becomes ſomewhat thicker and higher coloured. It is white in man when it has been mixed with the liquor of the proſtate. It has a peculiar ſmell in each claſs of animals; and it is the heavieſt humour in the human body. In water a part ſeparates into a kind of cuticle, like a cobweb, that ſwims in the liquid; the greater part, which is ſeemingly of a pulpy nature, falls to the bottom. In the ſemen which is long retained by chaſte people, ſhining globules mixed with the white liquor are eaſily to be ſeen. It has a very great quantity of mucus.

Without the conveyance of this into the womb, according to the opinion of Haller, no claſs of animals, of which there are two ſexes, can be fecundated ſo as to propagate their ſpecies; but Spallanzani has clearly proved, that, in certain kinds of animals commonly called *oviparous*, (excepting birds) fecundation takes place without the body of the female. The microſcope ſhews, that in man, as well as in all other male animals, the ſeminal liquor is full of living animalcula, reſembling eels, only with a thicker head; and that theſe are always preſent in healthy ſemen after puberty; but, before that time, and in thoſe who are ſterile from a gonorrhœa, they are abſent. That they are animalcula, appears evidently from their various apparent motions and jeſtures.

It has been much doubted what could be the uſe of theſe animalcula; and in another place we ſhall conſider the diſpute concerning the opinion, that they are as it were the firſt appearance of the future animal. Haller conſiders the nature of the ſeminal animalcula as the ſame with that of the eels in vinegar or paſte.

That the ſemen is produced from the lymph of the blood, and that the chyle is added to the lymph, will appear probable from

from the ſudden alacrity to venery that happens after eating, and which is leſſened by faſting. It is compounded of the liquor of the teſticles and ſeminal veſſels, the former indeed being more evident in ſome animals, and the coagulable milk of the proſtate gland. That liquor, however, only fecundates, which is generated in the teſticles, as we ſee in eunuchs, who, though they have the ſeminal veſſels and proſtate, are yet barren.

The ſeminal fluid is retained in the veſicles as long as a man neither exerciſes venery, nor ſports in imaginary dreams. It is always a ſtimulus to the animal appetite of venery, as long as it is there preſent in any quantity. Beſides this, there is a conſiderable ſtrong, volatile, and odorous part of the ſemen reabſorbed into the blood, where it produces wonderful changes as ſoon as it begins to be formed; ſuch as the protruſion of the beard, the covering of the pubes, a change of the voice and paſſions, horns in cattle, &c.; for theſe changes in the animal are not the conſequences of age, but of the ſeminal fluid, and are always abſent in eunuchs. The growth and ſtrength of caſtrated animals are conſtantly diminiſhed; and, in like manner, the fierceneſs of their temper, and the ſtrong ſmell of their whole body, are remarkably weakened. And, from the example of ſome animals, and even of mankind, it appears that the irritation of this fluid has occaſioned death, by exciting convulſions. A retention of the ſemen may follow from a narrowneſs of the excretory duct, a ſchirrhoſity of the proſtate, and other cauſes not ſufficiently known.

The quantity of ſemen expelled at one time from the human veſicles is but ſmall, more eſpecially in a man who has not long abſtained from venery; and it is natural to think that the liquor can be but ſlowly produced from ſo ſmall an artery. Its generation is accelerated by love, by the preſence of the beloved woman; ſo that it diſtends its veſſels with a ſenſe of pain.

Nature

Nature herſelf, therefore, enjoins venery, both for preſerving the human race, and the health of every individual. That it comes from the teſticle, is ſhewn by diſeaſes; in which the vas deferens being obſtructed, a ſwelling of the teſticle has enſued. The veſicles are never emptied, except by venereal actions and appetites.

In order that the ſemen, which is only in a ſmall quantity, ſhould be projected with a conſiderable force, it is previouſly mixed with another fluid from the proſtate. This gland prepares a thick, white, ſoft, cream-like liquor, in a large quantity, which is poured out at the ſame time, and from the ſame cauſes, with the ſemen itſelf, into a little channel at each ſide of the openings of the ſeminal veſicles, where, mixing with the ſeminal fluid, it imparts the white liquor and viſcidity which the ſemen poſſeſſes.

It was neceſſary for the canal of the urethra to be firm and capable of a direct figure, that it might be able to throw the ſemen with ſome ſtrength into the diſtant womb; and therefore a threefold cavernous body ſurrounds it.

Into the cavernous body of the urethra, the blood is poured out from the arteries, which come from deep branches ſent off from the external hæmorrhoidals; the truth of which is demonſtrated by the injection of any kind of fluid, which, being urged through the arteries, eaſily flows into thoſe cellular ſpaces ſurrounding the urethra. Theſe cells are not naturally turgid with blood, becauſe their are veins open, and numerous enough in proportion, to receive and return what is poured in by the arteries; but if the return is impeded by compreſſing thoſe veins, the blood is then retained within the cellular ſpaces, while the arteries continue to carry it more ſwiftly and ſtrongly than the veins return it. Thus the ſtagnant blood diſtends the bulb of

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the urethra, together with its cavernous body, and the glans itſelf. This diſtention is generally performed at the ſame time, when the other cavernous bodies of the penis, with which this of the urethra has no communication, are likewiſe rigidly diſtended.

Theſe cavernous bodies of the penis, having their ſpongy fabric diſtended in coition by the blood retained by the veins, and ſtill propelled by the arteries, become rigidly turgid, and ſuſtain the otherwiſe flaccid or but weakly filled urethra, in ſuch a manner that it may be able to conduct the ſemen into the diſtant womb. All this is demonſtrated from the diſſection of brute animals in the act of venery, from an artificial erection, and from the injection of liquid matters into the veſſels of the penis. The cauſes of this erection are love; the deſire of pleaſure; the friction of the glans; various irritations of the bladder, teſticles, ſeminal veſſels, and urethra, from the urine, from abundance of good ſeed, from the venereal poiſon, from cantharides, whipping the parts, and laſtly, from convulſion of the nerves. The proximate cauſe of this diſtention remains ſtill to be explained.

In order to diſtend the penis, there muſt be either a compreſſure of the vein, bringing back the blood from the cavernous bodies of the penis or urethra; or at leaſt it is neceſſary that there ſhould be a conſtriction of the leſſer veins that every where open within the cavernous bodies, to hinder them from abſorbing and returning the blood from the arteries. The firſt, however, may be effected by the levator, drawing up the proſtate and bladder; but it is very probable, that, as we ſee in the nipples of the breaſts, in the looſe pendulous gills of the turkey cock, and in the bluſhing or redneſs of the face from paſſions of the mind, erection may be produced without the immediate interpoſition of any peculiar muſcle. This ſuppoſition is confirmed by brute animals, which all couple without the uſe of any erector muſcle, by the erections which take place in animals to-

tally different from man, and especially those which take place in birds very quickly; and by the inactivity of the erector muscles themselves in the libidinous erection of the penis, and from their unfitness for compressing the veins. It is also probable, that an erection may be produced by the numerous ramifications of the nerves exciting a convulsive constriction of the veins; while, at the same time, the arteries, by an increased velocity of the blood, bring more blood to the parts than the veins can carry off. The cause of this convulsion is perhaps inherent in these nervous sphincters themselves, and depends either on a mechanical irritation of the nervous fibres, or on the force of the imagination.

A long continued and violent erection is at last accompanied with an expulsion of the semen; and this requires much greater force than is requisite for the erection only. For the semen is expelled when the irritation of the nerves is arrived at its greatest height; and in natural venery, when, at length, the cellular spaces of the urethra and its continuous glans, which are at last filled, become so far distended with a large quantity of warm blood, that the nervous papillae, stretched out in the latter, become violently affected from the irritating or pleasing cause. The seminal vesicles are emptied by the levator muscles of the anus, which press them against the resisting bladder with a convulsive motion, excited either by a voluptuous imagination, or by the exquisite sensibility of the nerves of the glans, principally in its lower part, which is in the neighbourhood of the frenum. Hence the semen is never discharged with any of the urine, in an healthy man; because the expulsion of it requires the bladder to be closed or drawn up firmly together; for while lax, it affords little or no resistance to the seminal vesicles. The transverse muscles seem to dilate the canal of the urethra for the reception of the semen expressed from the vesicles.

Soon

Soon afterwards the powers conſtringing the urethra are, from the irritation of the very ſenſible fabric of that canal, put into action. To this conſtriction conduces principally the accelerator, which makes a powerful concuſſion of the bulb and adjacent part of the urethra, ſo as to propel its contents more ſwiftly. But that this may act firmly, the ſphincter of the anus, together with that of the bladder, muſt be well ſhut. The accelerator muſcle ſeems alſo principally concerned in the erection, by compreſſing the veins of the corpus cavernoſum of the urethra. At the ſame time, the *erectores penis*, as they are called, ariſing from the tubercles of the iſchium, become tenſe, and are inſerted into the cavernous bodies, ſuſtaining the penis as a ſort of medium between the tranſverſe and perpendicular direction. Thus the ſemen is driven into the vagina, and into the uterus itſelf, in a prolific coition; the whole action of which is very impetuous, and comes near to a convulſion; whence it wonderfully weakens the habit, and greatly injures the whole nervous ſyſtem, as the maladies ariſing from thence, in conſequence of the affection of the nerves, without which the ſemen cannot be expelled, ſeem to indicate.

§ 5. *The parts of Generation in Females.*

The parts of generation in females are ſeveral in number, ſome of them external, and ſome internal; and they are all ſubordinate to one principal internal part, called the *uterus*. The other internal parts are the tubae Fallopianæ, ovaria, vaſa ſpermatica, ligamenta lata, the ropes or bands called *ligamenta rotunda*, and the canal of the uterus. The external parts are the pubes, the alae nymphae, clitoris, orifice of the urethra, and the orifice of the vagina.

Uterus. The uterus lies between the bladder and the inteſtinum rectum. It is a body inwardly hollow, outwardly of a whitiſh

whitiſh colour, of a ſolid ſubſtance, and, except in time of pregnancy, of the figure of a flat flaſk, being, in adults, about three fingers breadth in length, one in thickneſs, and two in breadth at one end, and ſcarcely one at the other. This ſize varies according to the age of the ſubject.

The broadeſt portion is termed the *fundus*, and the narroweſt the *neck*. Its ſituation is oblique, the fundus being turned backward and upward, and the neck forward and downward; the broad ſides lie next the rectum and bladder, and the narrow ſides are lateral.

The cavity of the uterus is flat, and reſembles an oblong triangle, the ſhorteſt ſide of which anſwers exactly to the fundus; and the two longeſt ſides lie, one on the right hand, the other on the left; and they are all bent inward, or toward the cavity formed by them.

Of the three angles of this cavity, the two which terminate the fundus are perforated each by a narrow duct, which, with difficulty, admits a hog's briſtle. The third angle forms a flat duct wider than the former, which perforates the neck of the uterus lengthwiſe, and terminates at the extremity of that neck, by a tranſverſe opening.

This opening is termed the *internal orifice of the uterus*; and, in the natural ſtate, is narrower than the duct of the neck of the uterus, ſo that only a ſmall probe can be paſſed through it. At the edge of this orifice are ſeveral ſmall holes, anſwering to the ſame number of glandular corpuſcles, which diſcharge a viſcid lymph.

The inner ſurface of the cavity of the uterus is lined by a very fine membrane, which at the fundus or broad portion is ſmooth and even; but, in the narrow portion which leads to the orifice, it is wrinkled in a particular manner.

The portion of this membrane which covers the bottom of the cavity, is perforated by a great number of conſiderable holes, through

through which ſmall drops of blood may be obſerved to paſs, when the whole uterus is compreſſed; and ſometimes it appears to have very ſmall hairs or villi. Theſe villi and holes are obſerved to be more or leſs tinged with blood in thoſe women who die in the time of their menſes.

In the narrow part, which anſwers to the neck, each ſide is divided into two lateral parts by a kind of prominent longitudinal line, which is larger in the upper or anterior ſide, than in the lower or poſterior.

On each ſide of theſe two longitudinal lines there are lines or rugae obliquely tranſverſe, and diſpoſed like branches, the longitudinal lines repreſenting trunks. Between and round theſe rugae, there are ſmall lacunae, through which a mucilaginous fluid is diſcharged that cloſes the orifice of the uterus. We ſometimes obſerve in the interſtices between the rugae, ſeveral tranſparent globular corpuſcles, which vary very much in ſize. There nature is not yet well underſtood: They appear to be filled with a mucous lymph. Naboth conſidered them as ova.

Structure of the uterus. The ſubſtance of the body of the uterus is ſpongy and compact, with a copious intertexture of veſſels. Its thickneſs is nearly equal and uniform in the ſides and edges; but the fundus is thicker toward the middle than toward the two angles, where the thickneſs decreaſes gradually. The edges are likewiſe much thinner near theſe angles than near the extremity of the neck.

The uterus is covered by a portion of the peritonaeum, which ſerves it for a coat, and is the continuation of that which covers the bladder and rectum, running up from the lower and poſterior part of the bladder, over the anterior part of the uterus, and from thence over the fundus, and down the poſterior ſide, and afterwards going to the rectum.

On each lateral part or edge of the uterus, this portion of the peritonaeum forms a broad duplicature, which is extended on each ſide, more or leſs directly to the neighbouring lateral parts

of

of the pelvis, forming a kind of membranous ſeptum, between the anterior and poſterior halves of the cavity of the pelvis; and it is afterwards continued in a looſe manner with the peritonaeum, on the ſides of the pelvis.

Broad ligaments of the uterus. Theſe two broad duplicatures have the name of *ligamenta lata*, and *veſpertilionum alae*. The upper edge of each is partly double, or folded, forming two ſmall diſtinct duplicatures, which may be termed the *pinions of the broad ligaments*. The anterior pinion is more raiſed than the poſterior, and they are both very looſe.

The laminae of all theſe duplicatures are connected by a cellular ſubſtance, in the ſame manner as the other duplicatures of the peritonaeum; and they contain the Fallopian tubes, the ovaria, a part of the ſpermatic veſſels, and of thoſe that go to the body of the uterus, the ropes called the *round ligaments*, the nerves, &c.

Ovaria. The ovaria are two whitiſh, oval, flat, oblong bodies, ſituated on the ſides of the fundus uteri, to which they are fixed by a kind of ſhort round ligament, and incloſed, together with it, in the duplicature of the poſterior pinion of the ligamenta lata.

They are compoſed of a compact ſpongy ſubſtance, and of ſeveral little balls, or tranſparent veſiculae, called *ova*; the number of which, according to Dr Haller, is found to be fifteen and upwards, though Sabatier ſays they are about ten or twelve, ſometimes more, ſometimes leſs, and that the liquor contained in them has all the qualities of lymph. The ſpongy ſubſtance ſurrounds each of theſe veſiculae very cloſely, and ſeems likewiſe to furniſh them with diſtinct ſpongy coverings or calices. Theſe veſiculae are carefully to be diſtinguiſhed from other preternatural ones, termed *hydatides*.

The ligaments of the ovaria lie in the edges of the poſterior pinions of the ligamenta lata, much in the ſame manner as the umbilical vein in the anterior or umbilical ligaments of the liver.

liver. They are round ropes of a filamentary texture, fixed by one extremity to the corner of the fundus uteri, a little above and behind the level of that fundus. They were formerly believed to be hollow, and considered as vasa deferentia.

Tubae Fallopianae. The Fallopian tubes are two flaccid, conical, and vermiform canals, situated more or less transversely on each side of the uterus, between the fundus and the lateral parts of the pelvis, and included in the anterior duplicatures or pinions of the ligamenta lata.

Each of them is fixed by its narrow extremities in the corner of the fundus uteri, into which it opens, though by so narrow a duct, as hardly to admit a large bristle. From thence their diameter augments by degrees all the way to the other extremity, where it is about one third part of an inch. The body of the tubae goes in a winding course, and their large extremity is bent toward the ovaria.

These large extremities are irregularly round, and terminate by a narrow orifice, a little plaited and turned toward the ovarium, where it presently expands in form of a membranous fringe, full of plaits and incisures. These fringes are called the *broad ends of the Fallopian tubes.*

The breadth of the fringe is not equal in all parts. Its circumference is in a manner oval, and the longest segment of the fringe reaches to, and is fixed in the ovarium. The folds are disposed like laminae on the concave side.

These tubes are composed of fleshy fibres, whereof some are longitudinal, and some obliquely circular, with an intertexture of another very fine substance.

The anterior pinions of the ligamentum latum serve for a common or external coat to both tubes, and also to connect them in the same manner as the mesentery connects the intestines. From thence the tubes, and especially their fringes, come

come to be looſe, and their direction to be very imperfectly determined.

Their cavity is lined by a ſoft glandular membrane, which is plaited longitudinally, almoſt like the inner ſurface of the aſpera arteria; and theſe folds are ſtronger and broader near the great extremities than any where elſe. Their ſubſtance ſeems to be ſpongy, and the interſtices between them are moiſtened more or leſs by a fluid which is continually diſcharged there.

Blood veſſels. The blood veſſels of theſe parts are of different kinds, viz. the hypogaſtric arteries and veins, the ramifications of which belong chiefly to the body of the uterus; the ſpermatic veſſels, and the two vaſcular ropes, called *ligamenta rotunda*, which might be more properly termed the *vaſcular ropes of the uterus* or of the *ligamenta lata*.

The hypogaſtric branches are arterial and venal ramifications, ariſing from the artery and vein of the ſame name; which having reached the lateral edges of the uterus, are diſtributed to all its parts, both internal and external, forming a great number of incurvations and particular intertextures.

The arteries of one ſide communicate both upon the uterus, and through its whole ſubſtance, with thoſe of the other ſide; and the arterial ramifications of each ſide form numerous anaſtomoſes with each other. The veins communicate together on each ſide in the ſame manner; and all theſe blood veſſels communicate likewiſe with the ſpermatic veſſels, with the vaſcular ropes of the ligamenta lata, and with the haemorrhoidales.

Theſe frequent anaſtomoſes may be demonſtrated by injecting or blowing into the hypogaſtric veſſels, having firſt made proper ligatures to prevent the liquor or air from running into other parts. The extremities of theſe arteries terminate and open into the cavity of the uterus, as has been already

already ſaid; and there is this peculiar to the veins, that they communicate with the haemorrhoidales, and conſequently with the vena portae.

The ſpermatic veſſels have nearly the ſame origin in females as in males, and likewiſe the ſame courſe and intertextures; but they never paſs out of the abdomen, being wholly diſtributed to the ovaria and tubes; and they communicate with the uterine hypogaſtrics, and with the vaſcular ropes of the ligamenta lata. The veins are very large in proportion to the arteries, and theſe veſſels ſend out lateral ramifications which ſeem to communicate with the meſeraicae and vena portae.

The vaſcular ropes, commonly called the *round ligaments*, are two long ſmall faſciculi of arteries, veins, and ligamentous fibres, interwoven and connected together by a fine cellular ſubſtance; and they run in the great duplicature of the ligamenta lata, from each corner of the fundus uteri, as far as the annular openings of the abdominal muſcles.

In this courſe, each rope thruſts outward or raiſes the anterior lamina of the duplicature, which conſequently gives a kind of coat to theſe vaſcular faſciculi, and makes them appear like diſtinct ropes connected to this foreſide of the duplicatures.

They ſeem to ariſe from the communication between the vaſa ſpermatica and hypogaſtrica, and might be reckoned a particular continuation of the ſpermatic veſſels. The diſpoſition of their adheſions to the angle of the fundus uteri, with reſpect to that of the tubes and ligaments of the ovaria, which lie all near each other, is this; The tubes lie higheſt, the ligaments of the ovaria moſt backward, and the vaſcular ropes forward, and a little lower than the ligaments of the ovaria.

Afterwards they run in a courſe, nearly reſembling that of the ſpermatic veſſels in males, paſs out of the abdomen,

through the openings of the abdominal mufcles, and are loft in the fat of the upper and middle parts of the groins. As they pafs out of the abdomen, they are accompanied by a production of the cellular portion of the peritonaeum, as the fpermatic rope in men, and by a fafciculus of flefhy fibres, repreſenting a kind of cremaſter.

Nerves, lymphatics, &c. Beſides all the veſſels hitherto mentioned, we obſerve nerves and lymphatics, to which we may add the lactiferous ducts that are ſeen in an advanced pregnancy. The nerves come from the lumbares, facri, and fympathetici maximi, in the ſame manner as in males. The lymphatic veſſels run chiefly in the coats continued from the peritonaeum.

Pubis. The pubis is that broad eminence at the lower part of the hypogaſtrium, between the two inguina, on which the hairs grow at a certain age, called in Latin by the ſame name, and almoſt of the ſame kind with thoſe found under the axillae. This eminence is owing to a particular thickneſs of the membrana adipoſa which covers the fore part of the oſſa pubis, and ſome ſmall portions of the neighbouring mufcles.

Sinus and alae. The longitudinal cavity which reaches from the middle and lower part of the pubes, within an inch of the anus, was by the antients termed *ſinus*; and they called the lateral parts of the cavity *alae*, which is a more proper name than that of *labia*, commonly given to them. The places where the alae are joined above and below are termed *commiſſures*, and may likewiſe be called *the extremities* or *angles of the ſinus*.

The alae are more prominent, and thicker above than below, and lie nearer each other below than above. They are chiefly compoſed of the ſkin, cellular ſubſtance, and fat. The exterior ſkin is a continuation of that of the pubes and inguina. It is more or leſs even, and furniſhed with a great number of glandular

dular corpuſcles, from which a whitiſh ceruminous matter may be expreſſed; and after a certain age it is likewiſe covered in the ſame manner with the pubes.

The inner ſide of the alae is ſomething like the red portion of the lips of the mouth; and it is diſtinguiſhed every where from the external ſide by a kind of line, in the ſame manner as the red portion of the lips from the reſt of the ſkin, being likewiſe thinner and ſmoother than the outward ſkin. A great number of pores are obſervable in it, and alſo numerous glandular corpuſcles, which furniſh a liquor more or leſs ſebaceous; and theſe corpuſcles are larger near the edges than in the other parts.

Lacunae. Near the inner edge of the inner ſurfaces of the alae, on each ſide of the orifice of the vagina, we find a ſmall hole more viſible than the reſt. Theſe two holes are termed *lacunae*, and they communicate by two ſmall ducts with the ſame number of follicular bodies lying in the ſubſtance of the alae, and which may be conſidered as ſmall proſtates, anſwering to the glandulae proſtaticae inferiores in males. When compreſſed, they diſcharge a viſcid liquor.

Above the ſuperior commiſſure, a thin flat ligament runs down from each ſmall branch of the oſſa pubis, which penetrates the fat in the ſubſtance of each ala, and is loſt therein inſenſibly near the edge. Theſe may be conſidered as the ligamenta ſuſpenſoria of the alae. The inferior commiſſure of the alae is very thin, or like a membranous ligament, and, together with the neighbouring parts of the inner ſide, it forms a foſſula termed *navicularis*, or *ſcaphoides*. The ſpace between the inferior commiſſure and anus, termed *perinaeum*, is about a large finger's breadth in length.

The other external parts are ſituated in the ſinus, and hid by the alae. Directly under the ſuperior commiſſure lies the clitoris with its cover, called *praeputium*. A little lower is the orifice of the urethra: and below that is the orifice of the great canal

canal of the uterus. The circumference of this orifice is bordered, either by a membranous circle, called *hymen*, or by fleſhy portions, termed *carunculae myrtiformes*. On each ſide of the clitoris begins a very prominent fold, like a criſta, which runs down obliquely on each ſide of the orifice of the urethra. Theſe folds are termed *nymphae*, and they might likewiſe be named *criſta clytoridis*. On each ſide of the great orifice lies the ſmall proſtatic hole already deſcribed.

Clitoris. The clitoris appears at firſt ſight like a ſmall imperforated glans. Its upper and lateral ſides are covered by a kind of praeputium, formed by a particular fold of a portion of the inner ſide of the alae, which appears to be glandular, and to diſcharge a certain moiſture, and its inſide is granulated.

By diſſection, we diſcover in the clitoris a trunk and two branches, as in the penis, conſiſting of a ſpongy ſubſtance, and of very elaſtic coats, but without any urethra. This ſubſtance may be inflated either by air or anatomical injections into the artery, &c. The trunk is divided into two lateral parts by a middle ſeptum, from the bifurcation to the glans, where it is inſenſibly loſt.

The bifurcation of the trunk is on the edge of the cartilaginous arch of the oſſa pubis; and the branches, which reſemble the roots of the corpora cavernoſa, are inſerted in the inferior rami of theſe bones, and in thoſe of the oſſa iſchium, where they terminate by degrees; but there is ſometimes a membranous tube on each ſide, which reaches to the tuberoſity of the iſchium.

The trunk of the clitoris is ſuſtained by a ligamentum ſuſpenſorium fixed in the ſymphyſis of the oſſa pubis, and containing this trunk in its duplicature, nearly as in the other ſex.

Four

Four muſcles or faſciculi of fleſhy fibres are inſerted in the trunk of the clitoris, two on each ſide. One of them runs down on the foreſide of the neighbouring corpus cavernoſum, and is inſerted by a tendinous or aponeurotic portion, partly in the extremity of the corpus cavernoſum, and partly in the tuberoſity of the iſchium. Theſe two muſcles are called *erectores*; but the name of *iſchio-cavernoſi* would be more proper.

The other muſcle on each ſide lies under the former, and runs down on the ſide of the urethra and great orifice of the uterus, all the way to the anus, increaſing gradually in breadth in its paſſage, and terminating partly like that which is called *accelerator* in males.

Theſe two muſcles ſurround very cloſely the lateral parts of the urethra and of the great orifice. They expand very much as they deſcend, and are ſpread on the lower and lateral parts of the great orifice; for which reaſon ſeveral anatomiſts have conſidered them as muſcular ſphincters. All theſe four muſcles, and eſpecially the two latter, are oftentimes almoſt covered with fat.

The blood-veſſels of the clitoris come chiefly from the hypogaſtricae, and the nerves from the ſecond and third pairs of the nervi ſacri, by means of which they communicate with the inferior meſenteric plexus, and with the great ſympathetici.

Nymphae. The nymphae, criſtae clitoridis, or, as they may likewiſe be termed, *alae minores ſive internae*, are two prominent folds of the inner ſkin of the great or external alae, reaching from the praeputium of the clitoris to the two ſides of the great orifice of the uterus. They begin very narrow, and, having increaſed in breadth in their courſe downward, they are again contracted at their lower extremity.

They

They are of a ſpongy ſubſtance, intermixed with glands, ſeveral of which may be perceived by the naked eye. Their ſituation is oblique, their upper extremities lying near each other, and the lower at a much greater diſtance. In married women they are more or leſs flaccid and decayed.

Urethra. By the urethra in females, we mean the urinary duct, the orifice of which is between the nymphae below the glans of the clitoris. The ſides of this orifice are a little prominent and wrinkled, and perforated by ſmall lacunae, from which a viſcid or mucilaginous liquor may be ſqueezed. In time of pregnancy, this orifice is ſometimes drawn a little inward.

The body of the urethra is a ſpongy duct of the ſame ſtructure as in males, but much ſhorter, ſituated directly under the trunk of the clitoris, and above the great canal of the uterus, adhering to each of theſe canals, between which it lies by membranous filaments. It paſſes under the cartilaginous arch of the oſſa pubis, and terminates by an oblique opening at the neck of the bladder, being bent a little downwards between its two extremities.

The internal membrane of the urethra is a little plaited, and perforated by ſmall holes, which communicate with folliculi, lying hid in its ſubſtance, as in males. If we blow into one of theſe holes, we obſerve a ſmall canal to be inflated, which runs from without inwards, and terminates in ſome places by a kind of ſacculus, by compreſſing which a viſcid liquor is diſcharged.

The continuation of this membrane, which lines the neck of the bladder, forms likewiſe ſeveral rugae, more or leſs equal; but that which lines the cavity of the bladder is wrinkled in an irregular manner when the bladder is empty.

The vagina. The great canal, formerly called the *neck* of the uterus, is ſituated below the urethra, and above the extremity of the inteſtinum rectum, a little obliquely, being more raiſ-

ed

ed on the inner and back part than on the outer and fore part.

Its inner or posterior extremity joins the extremity of the body of the uterus, and surrounds its orifice much in the same manner as the duodenum surrounds the pylorus, or as the ileum is surrounded by the caecum and colon.

The anterior extremity forms the great orifice, which lies under that of the urethra, and above the fossula of the inferior commissure of the alae.

The body of the canal is chiefly composed of a spongy substance, interwoven with numerous blood-vessels; and it is commonly longer and narrower in virgins than in married women.

Its inner or concave surface has several transverse rugae, and is covered by a particular membrane. The rugae are formed by oblong narrow eminences, incurvated like portions of arches, placed very near each other, and disposed in such a manner as to divide the cavity of the canal into an upper and lower side.

By the union of the extremities of the upper and lower rugae, a kind of raphe or suture is formed on the right and left sides; and both arches are sometimes interfected in the middle, and so form two half arches; but in this there is some variety.

In general, these arches are very considerable in young persons; become gradually more superficial in married women, and are quite lost in time of delivery.

The inner or posterior extremity of this great canal surrounds the orifice of the uterus a little obliquely, in such a manner as that the upper side of the canal lies very near the orifice, and the lower side at a greater distance from it; and this makes the extremity of the uterus appear to advance more into the canal on the lower than on the upper part.

Circulus

Circulus membranoſus. The exterior or anterior extremity of the great canal in virgins, and eſpecially before the firſt eruption of the menſes, is commonly bordered by circular membranous folds of different breadths, more or leſs ſmooth, and ſometimes ſemilunar; which, in ſome ſubjects, leaves but a very ſmall opening, in others a larger opening; and, in all, renders the external orifice narrower than the reſt of the cavity. This fold, called *hymen*, is formed by the union of the internal membrane of the great canal with that on the inſide of the alae, and repreſents a membranous circle of different breadths, and ſometimes uneven.

Carunculae. This membranous circle is commonly ruptured after the conſummation of marriage; is quite loſt in delivery, and afterwards only ſome irregular portions of it remain; which, from their ſuppoſed reſemblance to myrtle-leaves, have been termed *carunculae myrtiformes*. This circle may likewiſe ſuffer ſome diſorder by too great a flux of the menſes, by imprudence, levity, and other particular accidents.

Plexus retiformis. Each ſide of the anterior portion of the great canal is covered exteriorly by a thin, broad, cavernous, and vaſcular plexus, called the *plexus retiformis* of that canal. Theſe two planes run down on each ſide of the clitoris behind the nymphae, and likewiſe cover the urethra like a collar, before they are ſpread on the great canal.

This plexus is ſtrictly united to the muſcular portions, commonly taken for accelerators or conſtrictors, lying between theſe portions and the lateral parts of the urethra, and of the great canal.

This plexus may be inflated by air like a flaccid ſpleen, or like the ſpongy ſubſtance of the clitoris, with which it ſeems to have ſome communication; and on this account the lateral portions of this reticular plexus have been named the *internal* crura of the clitoris. It is a kind of rete-mirabile, compoſed

compoſed of veſſels which come chiefly from the hypogaſtricae.

It ſtill remains to be obſerved, that, on each ſide of the bottom of the pelvis, in both ſexes, oppoſite to the lower part of the bladder, there is an aponeurotic or tendinous ligament, which runs over the inner ſurface of the muſculus obturator internus from before backward. The anterior extremity of this ligament is fixed on one ſide of the middle portion of the ſymphyſis of the oſſa pubis, and the poſterior extremity to the middle part of the ligamentum ſacro-ſciaticum, formerly deſcribed.

A little above the elongation called the *neck* of the bladder, there is another ligamentary expanſion on each ſide of the bladder; the fore part of which is narrow, and fixed to the anterior extremity of the ligament already mentioned; and the broad poſterior part to the ſide of the bladder. Theſe two lateral expanſions may be conſidered as proper ligaments of the bladder, by which it is connected to the inner ſide of both oſſa pubis.

EXPLANATION OF TABLE XI.

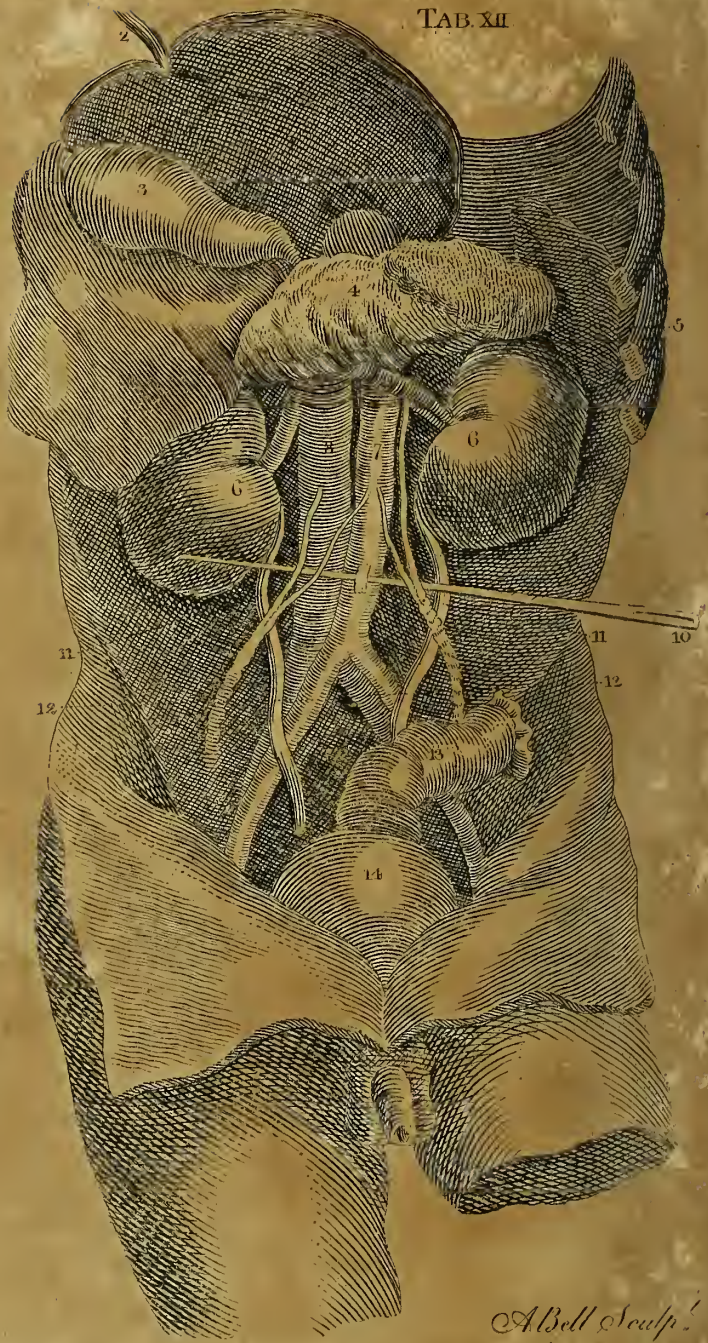
1. Trachea.
2. The internal jugular vein.
3. The ſubclavian vein.
4. Vena cava deſcendens.
5. The right auricle of the heart.
6. The right ventricle, the pericardium being removed.
7. Part of the left ventricle.
8. Aorta aſcendens.
9. Arteria pulmonalis.
10. The right lobe of the lungs, part of which is cut off to ſhew the great blood veſſels.
11. The left lobe of the lungs.
12. The diaphragm.
13. The liver.
14. The ligamentum rotundum.
15. The bottom of the gall-bladder projecting beyond the anterior edge of the great lobe of the liver.
16. The ſtomach, preſſed by the liver toward the left ſide.
17. The ſmall guts.
18. The ſpleen.

EXPLA-

TAB. XI.

A Bell Sculp.

TAB. XII



A Bell Sculp.

EXPLANATION of TABLE XII.

1. The under ſide of the liver.
2. Ligamentum rotundum.
3. The gall-bladder.
4. The pancreas.
5. The ſpleen.
6. The kidney.
7. Aorta deſcendens.
8. Vena cava aſcendens.
9. The emulgent vein.
10. A probe under the ſpermatic veſſels and the arteria meſenterica inferior, and over the ureters.
11. The ureter.
12. The iliac veſſels.
13. The inteſtinum rectum.
14. The bladder of urine.

EXPLA-

EXPLANATION OF TABLE XIII.

FIGURE I. Gives a front view of the *uterus in ſitu* ſuſpended in the vagina; the anterior parts of the oſſa iſchium, with the oſſa pubis, pudenda perinaeum, and anus being removed.

A The laſt vertebra of the loins.

BB The oſſa ilium.

CC The acetabula.

DD The inferior and poſterior parts of the oſſa iſchium.

E The part covering the extremity of the coccyx.

F The inferior part of the rectum.

GG The vagina cut open longitudinally, and ſtretched on each ſide of the collum uteri, to ſhew in what manner the uterus is ſuſpended in it.

HH Part of the veſica urinaria ſtretched on each ſide of the vagina, and inferior part of the fundus uteri.

I The collum uteri.

K The fundus uteri.

LL The tubæ Fallopianæ and fimbriæ.

MM The ovaria.

NN The ligamenta lata and rotunda.

OO The ſuperior part of the rectum.

FIGURE II. Gives a view of the internal parts as ſeen from the right groin, the pelvis being divided longitudinally.

A The laſt vertebra of the loins.

BC The os ſacrum.

D The left os ilium.

E The inferior part of the left os iſchium.

F The os pubis of the ſame ſide.

G The foramen magnum.

H The acetabulum.

III The inferior part of the rectum and anus.

TAB. XIII

D. Lizars Sculpt

K The os externum and vagina, the os uteri lying loosely in it.

L The vesica urinaria.

MN The column and fundus uteri, with the view of the cavity of both. The attachment of the vagina round the outside of the lips of the mouth of the womb is likewise here shewn; as also the situation of the uterus, as it is pressed downwards and backwards by the intestines and urinary bladder into the concave and inferior part of the os sacrum.

O The ligamentum latum and rotundum of the left side.

PP The Fallopian tube with the fimbriae.

Q The ovarium.

RR The superior part of the rectum, and inferior part of the colon.

FIGURE III. Gives a front view of the uterus in the beginning of the first month of pregnancy, the anterior part being removed, that the embryo might appear through the amnios, the chorion being dissected off.

A The fundus uteri.

B The collum uteri, with a view of the rugous canal that leads to the cavity of the uterus.

C The os uteri.

EXPLA-

EXPLANATION OF TABLE XIV.

Repreſents the *abdomen* of a woman opened in the ſixth or ſeventh month of pregnancy.

AAAA The parietes of the abdomen opened and turned back to ſhew.

B The uterus.

CCC The inteſtines raiſed upwards.

From this figure it appears, that the ſtretching of the uterus can eaſily be felt at this period, in lean ſubjects, through the parietes of the abdomen, eſpecially if the inteſtines do not lie before it. In general, indeed, as the uterus ſtretches it riſes higher, by which means the inteſtines are alſo raiſed higher, and are likewiſe preſſed to each ſide. Hence the nearer the woman is to her full time, the ſtretching is the more eaſily felt.

TAB. XIV.

D. Lizars Sculpt

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TO VOLUME SECOND.

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